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VOLUME 3

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FINAL REPORT

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FLEET RELIABILITY ASSESSMENT PROGRAM

AN/WSC-3 SATELLITE COMMUNICATION SET

NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER
VALLEJO, CALIFORNIA

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The report discusses the development of a failure reporting, analysis and corrective action program designed for early identification of maintenance problems encountered with new electronic equipment installations aboard ships, and the results of the program at the conclusion of the pilot phase.

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(6)

FLEET RELIABILITY ASSESSMENT PROGRAM.

Volume 3.

AN/WSC-3 SATELLITE COMMUNICATION SET. Volume 3.

NAVAL ELECTRONIC SYSTEMS ENGINEERING CENTER
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(10) David J. /Hoffman, Jack E. /Ekwall
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FLEET RELIABILITY ASSESSMENT PROGRAM

DEPARTMENT OF THE NAVY

NAVAL ELECTRONIC SYSTEMS COMMAND

PREPARED UNDER THE DIRECTION OF

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AN/WSC-3 EQUIPMENT REPORT

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SECTION I - INTRODUCTION

1-1 EQUIPMENT.

1-1.1 AN/WSC-3. The AN/WSC-3 is a Satellite Communications Set that operates in the Ultra High Frequency (UHF) (300MHz-3GHz) portion of the spectrum. The set provides voice, teletype, and digital data communications by satellite or line-of-sight (LOS) for the Fleet on a world wide basis. AN/WSC-3's are installed on surface ships in either single or multiple installations utilizing the OE-83B/WSC-1 trainable, directional antenna system for satellite data operation, and a conventional UHF omnidirectional antenna for LOS operation. On submarines the single AN/WSC-3 installations can be operated ship-to-ship LOS or with the satellite using the OE-158 antenna or equivalent.

1-2 INSTALLATIONS.

1-2.1 At the start of the data collection period, delivery of the AN/WSC-3 from the contractor had been under way for approximately six months. FRAP platforms designated by the type commanders were under an accelerated installation schedule. All platforms had relatively new installations at the beginning of Data Collection Period. Atlantic Fleet users had limited access to a communications satellite approaching end-of-life in the period before SATCOM satellites were launched.

SECTION II - RESULTS

2-1 RELIABILITY, MAINTAINABILITY, AND AVAILABILITY

2-1.1 RELIABILITY AND MAINTAINABILITY. In Fleet operations, the AN/WSC-3 is meeting the specified MTBF of 3000 hours. The Fleet is in substantial compliance with the specified time to repair of ten minutes (0.17 hours). The Atlantic Fleets' learning experience with the end-of-life communications satellite appears to be reflected in differences between the Fleets with the AN/WSC-3's in the Atlantic Fleet having a much larger MTBF and smaller repair times than the AN/WSC-3's in the Pacific Fleet.

2-1.2 AVAILABILITY. The operational availability (average of .9453 and .9355 for Atlantic and Pacific Fleet, respectively) is being degraded by large down-times. The Atlantic Fleet has the largest down times and magnitude is such as to nearly overcome the Atlantic Fleets MTBF advantage. Part of the large down time observed in the Atlantic Fleet is due to it and the Supply system originally having different replacement modules lists. It is recommended that the technique described in Appendix E of Volume 7 be used in establishing replacement modules quantity and type.

2-2 HARDWARE PROBLEMS

2.2.1 AN/WSC-3. No O-Level module performed significantly worse than predicted when operating time was considered. However, analysis of depot repair results indicate possible problems may be developing. Therefore, it is recommended that modules being returned to the repair depot be monitored for significantly high return rates and for low verification ratios.

2-2.2 SATCOM SYSTEM PROBLEMS. The maintenance of the proper power output level for SATCOM operations has been quite troublesome. The scale of the meter should be redesigned if its present application is to continue. Also, the OE-82B/WSC-1(V) steerable antenna array used on surface ships for SATCOM operations is a major problem area. There appears to be a need for (1) stressing training of WSC-3 operators in the antenna operation, and (2) corrective actions on the Scott-Tee card.

SECTION III - SYSTEM DESCRIPTION

3-1 MISSION DESCRIPTION

3-1.1 The AN/WSC-3 Shipboard Satellite Communication Set provides two modes of operation; line of sight (LOS) and satellite communications (SATCOM). The set will transmit and receive AM, FM, FSK and PSK signals via a UHF satellite in the SATCOM mode. In the LOS mode the set will transmit and receive signals in the 225 - 400 MHz range. In the line of sight mode the transmit and receive frequencies are identical, (Simplex). In the SATCOM mode the receiver frequency is offset below the transmit frequency by a programmable amount. The offset takes place automatically when switching between transmit and receive.

3-1.2 As the AN/WSC-3 is typically used, it is a dedicated SATCOM system operating in PSK mode exclusively at bit rates up to 9600 bits/sec.

3-1.3 In addition to the operational functions, the equipment also contains built-in test capabilities. The built-in test equipment (BITE) provides for a limited continuous monitor of those functions which may be checked without interference with the operational signals and manual front panel intiated tests for interrupted service type testing. The BIT permits functional testing of the communications set as well as maintenance fault isolation to the replaceable module. The status of the monitored functions and/or testing displayed on the front panel.

3-2 EQUIPMENT DESCRIPTION

3-2.1 The AN/WSC-3 consists of a Receiver-Transmitter and a Control Indicator. The transceiver provides 100 watts for FM voice FSK, and PSK data communications and 30 watts AM for narrowband voice, or secure voice when used in conjunction with the TSEC/KY-8. The communications set includes an internal modem for transmission and a reception of 75 baud teletype and 300, 1200, 2400, 4800, and 9600 baud digital data and an external Radio Set Control unit for remote operation. The transceiver is entirely solid state and provides for operation on 7000 channels in the 225 to 399.975 MHz frequency band with 25 KHz channel spacing. Frequency selection is accomplished either through a manual thumbwheel 7000 channel selector or through a preset memory. Any 20 of the 7000 channels may be programmed into the preset memory. A 70 MHz provision has also been included to permit the use of an external modem in the place of the internal modem. The AN/WSC-3 requires 115/230 Vac 60 Hz at a maximum of 11 amperes.

3-2.2 The submarine installations use a double disk-cone omnidirectional antenna on an extendible boom. Surface ships use two OE-82B/WSC-1 trainable arrays, one fore and one aft, linked to the ship's gyro system to hold their orientation (see Figure 3-3.1). The AN/WSC-3 is typically located in a radio room below deck in an air-conditioned environment. The communications set is rack mounted and slides open forward for adjustment and module replacement. A small remote control box is used if manual remote control is desired. Maintenance is normally performed by radio room personnel using the built-in-test equipment (BITE) features of the set. Repair is by module replacement.

3-2.3 Control of the communications set may be attained either at the front panel or through the remote control unit. The remote control unit has provisions for a handset, selection of any of the 20 preset channels, and selection of the type of modulation. It also contains a handset volume control and has lamps to indicate operating conditions.

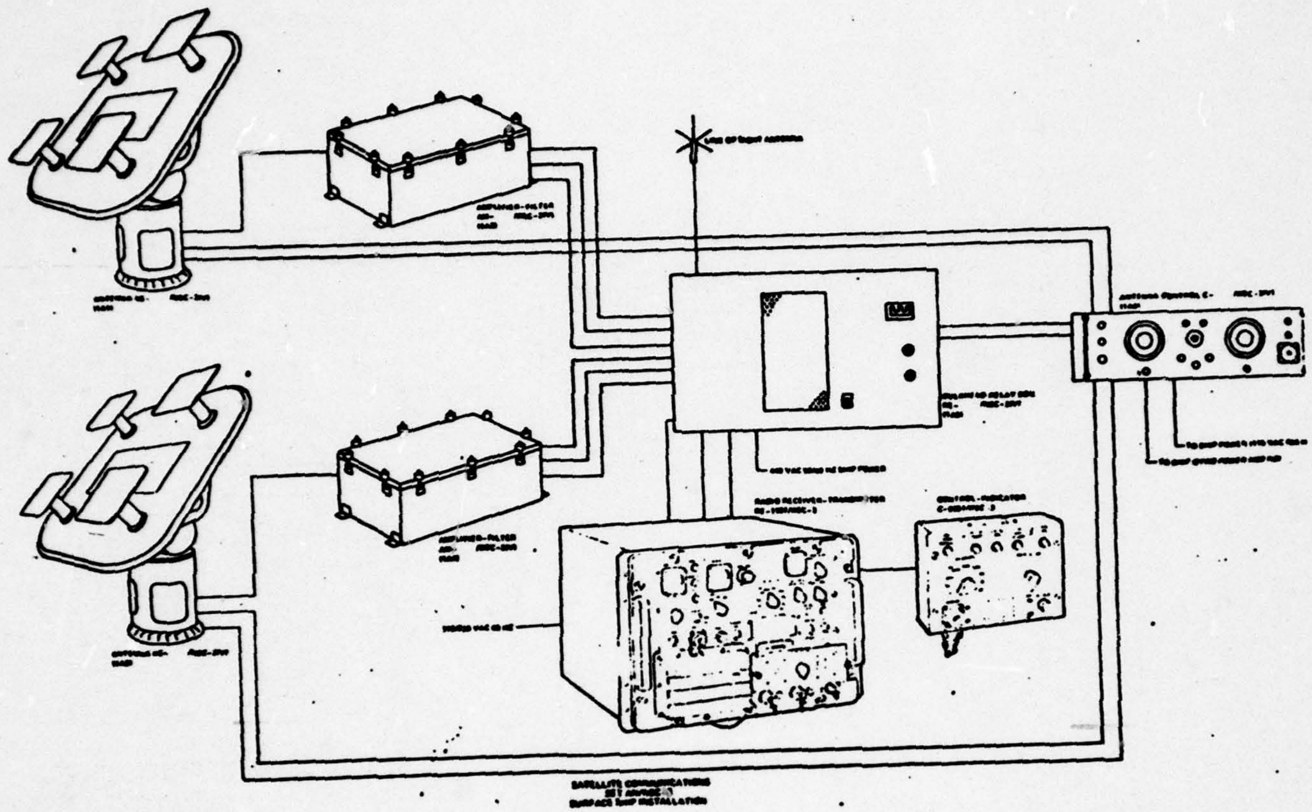


FIG 3-3.1 AN/WSC-3 SHIPBOARD INSTALLATION

SECTION IV - RELIABILITY MODEL

4-1 RELIABILITY BLOCK DIAGRAM

4-1.1 BY O-LEVEL REPLACEMENT MODULES. Figure 3-4.1 lists all the AN/WSC-3's O-Level replacement modules by reliability block number with the following information: nomenclature, reference designation, manufacturer's stock number, national stock number, predicted (MIL-HDB-217) failure rate provided by manufacturer, and number used. Considering only on time (no difference between receive and transmit effects), the reliability block diagram for the AN/WSC-3 is those modules connected in series.

4-1.2 BY MODES. If the reliability by modes is desired, then only the O-Levels in that mode are included in the reliability block diagram. Further if it is desired to consider the difference between transmit and receive effects, the O-Level involved in each must be specified. Figure 3-4.2 gives the modules involved in the receive and transmit functions for the AM, FM, FSK and PSK modes. The reliability block diagram for each mode is these O-Levels connected in series.

4-2 MAINTAINABILITY MODEL

4-2.1 The mathematical model for each mission (mode) reliability is as follows:

$$R = R_R \cdot R_T \qquad (1)$$

$$= \mathrm{EXP}[-\lambda_R t_R] \cdot \mathrm{EXP}[-\lambda_T t_T] \qquad (2)$$

where λ_R is the sum of the failure rates of the O-Level modules involved in the receiving function and t_R is the time involved in receiving and λ_T and t_T are the same but for the transmit function. Equation (2) assumes each O-Level module's failure rate follows an exponential distribution.

4-3 COMPUTER PROGRAM

4-3.1 The above model was programmed in "BASIC" computer language for the AM, FM, FSK and PSK modes. Using this computer program, the mission reliability and MTBF can be calculated for various mission times with various allocations of receive and transmit time. Figure 3-4.3 presents the results of running this program for missions times of 500 and 1000 hours with 10% transmit time and 90% receive time. The failure rates used are those given in Figure 3-4.1.

Reliability Block Number	Nomenclature	Ref. Desig.	Manufacturers Stock No.	National Stock No.	Failure Rate/10^6 HR	No. Used
001	Power Supply	A1A2	03-03236-001	4G-6110-01-014-3840	45.0694	1
002	Remote Control Box	A1A24	03-02981-001	4G-5820-01-021-6135	1.0000	1
003	Preset Switch Assy	A1A20	03-03228-001	4G-5820-01-021-6133	11.4359	1
004	Frequency STD	A1A23	69-00274-002		1.0000	1
005	Synthesizer	A1A8	03-02910-002	4G-5820-01-025-4076	32.2321	1
006	Control Convtr	A1A9	03-03237-001	4G-5820-01-021-6439	10.7709	1
007	T/R Switch	A1A21	03-02911-001	4G-5820-01-021-6445	3.4350	1
008	Translator	A1A6	03-02897-001	4G-5820-01-021-6131	7.7264	1
009	Transmitter	A1A1	03-03246-001	4G-5820-01-008-2159	64.3791	1
010	First Mixer	A1A18	03-03290-001	4G-5820-01-008-2160	13.8527	1
011	Second Mixer	A1A17	03-03288-001	4G-5820-01-008-6154	11.2579	1
012	Voltage Cont Osc.	A1A22	73-00045-001	4G-5820-LL-HHA-2038	13.9649	1
013	FM Detector	A1A14	61-01512-001	4G-5820-01-025-4086	4.1391	1
014	AM Detector	A1A15	61-02011-001	4G-5820-LL-HHA-2036	15.4497	1
015	FM/PSK/FSK Demod	A1A10	03-02907-001	4G-5820-LL-HHA-2017	27.0102	1
016	Main IF Amp	A1A16	61-01514-001	4G-5820-LL-HHA-2025	14.1097	1
017	Data IF Mixer	A1A13	61-01518-001	4G-5820-01-021-6413	4.1391	1
018	PSK Detector	A1A7	03-03227-001		33.2712	1
019	Freq Auto Sweep	A1A12	61-01785-001	4G-5820-01-021-6137	13.9649	1
020	FSK Detector	A1A4	03-02898-001	4G-5820-01-021-6132	13.6830	1
021	Data Buffer	A1A19	03-03223-001	4G-5820-01-021-6138	3.7273	1
022	PSK RCV Logic	A1A3	61-01784-001	4G-5820-01-021-6134	10.3719	1
023	PSK XMT Logic	A1A5	61-02076-001	4G-5820-01-013-6190	13.7531	1
024	Wiring		None	None	0.005	
025	Chassis		None	None	0.005	
026	BITE Module	A1A11	61-01520-001	4G-5820-01-021-6136	3.7336	1
					373.4871	

AN/WSC-3 O-LEVEL MODULES

FIGURE 3-4.1

AM MISSION		FM MISSION	
Receive	Transmit	Receive	Transmit
R026	R026	R026	R026
001	001	001	001
002	002	002	002
007	007	007	007
024	024	024	024
025	025	025	025
005	009	005	009
019	008	019	008
021	005	021	005
010	019	010	019
003	021	003	021
004	006	004	006
011	010	011	010
016		016	015
012		012	
017		017	
018		018	
014		014	

FIGURE 3-4.2 MODEL MISSIONS

FSK MISSION

Receive	Transmit
026	026
001	001
002	002
007	007
024	024
025	025
005	009
019	008
006	005
010	019
004	021
011	006
016	010
017	015
018	
020	
022	
021	

PSK MISSION

Receive	Transmit
026	026
001	001
002	002
007	007
024	024
025	025
005	009
019	008
006	005
010	019
004	021
003	006
011	010
016	015
012	023
017	
018	
020	
022	
021	

FIGURE 3-4.2 CONTINUED

```
 77/03/28. 15.49.23.
PROGRAM   RMOD9

TYPE MISSION TIME IN HOURS
? 500
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 1
TOTAL RELIABILITY FOR AM MISSION    .918997
MISSION MTBF=  2567.95
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 500
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 2
TOTAL RELIABILITY FOR FM MISSION   .916049
MISSION MTBF=  2377.75
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 500
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 3
TOTAL RELIABILITY FOR FSK MISSION   .907506
MISSION MTBF=  2327.74
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 500
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 4
TOTAL RELIABILITY FOR PSK MISSION   .892357
MISSION MTBF=  2141.28
```

Figure 3-4.3 Page 1 of 2

```
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 1000
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
YPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 1
TOTAL RELIABILITY FOR AM MISSION   .844555
MISSION MTBF=  2567.95
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 1000
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 2
TOTAL RELIABILITY FOR FM MISSION  .839145
MISSION MTBF=  2377.75
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 1000
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 3
TOTAL RELIABILITY FOR FSK MISSION  .823568
MISSION MTBF=  2327.74
TYPE Y TO CONTINUE
? Y
TYPE MISSION TIME IN HOURS
? 1000
TYPE PERCENT OF MISSION TIME TRANSMIT
? 10
TYPE PERCENT OF MISSION TIME RECEIVE
? 90
FOR AM, FM, FSK, OR PSK TYPE 1, 2, 3, OR 4
? 4
TOTAL RELIABILITY FOR PSK MISSION  .796301
MISSION MTBF=  2141.28
TYPE Y TO CONTINUE
? N
```

Figure 3-4.3 Page 2 of 2

SECTION V - PROBLEMS

5-1 AN/WSC-3

5-1.1 SPECIFIC MODULES. No module level problems were definitely identified. Two modules showed high failure rates in the Pacific FRAP Sample but not in the Atlantic and not in the population as a whole (based on depot data). Four modules were identified from depot data as high return rate items. None of these showed up as problems in the field study. It is concluded that the four depot identified problem areas are not severe enough to be considered significant problems when equipment operating time is considered. The two Pacific problem areas are probably related to start-up since the Atlantic Fleet, which has more SATCOM experience, had no problem with these modules.

5-1.2 GENERAL. The following problems were discovered during discussion with Fleet and depot repair personnel:

(1) FORM 1483. It was discovered that incoming inspectors at the depot repair facility were pulling and discarding the DD Form 1483, which calls out the reason for return. This forced repair technicians to work blind and resulted in some problems not being found. This practice has been halted and the Fleet symptomatic information now accompanies the returned module to the test/repair station.

(2) MODULE ADJUSTMENTS. Some modules have returned to depot maladjusted but otherwise fully functional. Adjustments made at depot are now being "Glyptol-ed", i.e., secured with a dot of waxy paint. This prevents movement during handling and discourages knob twiddling in the field.

(3) INTERCHANGEABILITY. Comments from Fleet users which were confirmed by the check-out technician at Charleston indicate that some inter-reaction problems exist such that not all modules are truly interchangeable. Some will not work in one radio set but will function fine in another.

(4) DEPOT TEST CORRELATION. Modules from the AN/WSC-3 are tested at depot repair on test stands using jigs to hold the module and various signal sources and loads to simulate operating conditions. This is standard practice and is valid, so long as correlation is established and maintained between simulation and field performance. Indications from depot data and Fleet inputs are that a correlation problem exists.

(5) STANDARDIZATION OF LEVELS. Verbal comments picked up during FRAP field trips indicates that a problem exists in the area of signal level standardization. Apparently the tolerances utilized during manufacturing and repair are excessive. The Phase Shift Keyed (PSK) detector module, for example, shows a low verification ratio. Symptomatic remarks accompanying the returns clearly detail the observed problems: "Module not locking on at the prescirbed level of -3VDC" and "Too high a voltage shift, (when measured on the oscilloscope) between 1200, 2400, and 4800 BPS". These failures were not confirmed at the Repair Depot. Opinions were expressed that these PSK modules are being set too close to the spec limit at the factory. This situation apparently is happening elsewhere and Fleet users feel it is necessary to attempt to "touch up" the adjustments on the modules (see (2)). Merely tacking the factory settings with Glyptol will not succeed if those settings are wrong.

5-2 SATCOM SYSTEM PROBLEMS.

5-2.1 RF POWER OUTPUT LEVELS. The AN/WSC-3 was designed to output up to 100W (+20dbW or +20dB in a 50 ohm system) in PSK mode. The SATCOM satellite has been found to be quite susceptible to cross-talk from excessively high signal levels. The trainable array used by surface ships has roughly 10db (ten times) gain so that a ship might output as much as 1,000 Watts of RF power at the satellite. SATCOM control has directed shipboard users to transmit between 0.5 and 1.25 W total output power, which is between -9 and -13 dB at the set. The AN/WSC-3 required circuitry modifications to operate at these very low power levels (between 0.05 and 0.125W output). The power output meter, which has a standard logarithmic scale, is reading in the highly compressed part of its scale at -9 to -13 dB. As the user on the USS JOUETT, CG-29, put it, "It is felt a better system should be devised to give a more accurate output db reading. The present system is more like setting up a range than setting one level".

5-2.2 TRAINABLE ANTENNA. The OE-82B/WSC-1 steerable array has become an unexpected major problem. It has been previously deployed with the AN/WSC-1 and should have been thoroughly shaken down. However, comments from users indicate that the antenna steerable mount control system is a headache. FRAP has no estimates of the mount's performance parameters since FRAP was not authorized to collect data on it (although some users sent comments and several unloaded at FRAP interviewers). The Scott-Tee card was frequently mentioned as a problem. Replacement cards were said not to hold up and often failed shortly after installation. A thermal run-away condition was identified on one OE-82B System card by MOTU-1 at Pearl Harbor. Other thermally related problems are suspected since one Pacific user complained that the control system "went wacky after 10 minutes of op time". NESEC Charleston put forth the opinion that part of the problem is related to training, saying that AN/WSC-3 users get virtually no training on the OE-82 mount while the AN/WSC-1 users did get training and had no problems.

SECTION VI - CORRECTIVE ACTIONS

6-1 AN/WSC-3 PROBLEM MODULES

6-1.1 No module was conclusively determined to be in need of corrective action.

6-2 SATCOM SYSTEM PROBLEMS.

6-2.1 TRANSMIT POWER LEVEL. An systems level operations problem exists in re-establishing after maintenance the proper output power level for SATCOM operation. Refer to 9-3.2 for a discussion of the problem.

6-2.2 STEERABLE ANTENNA. The OE-82B/WSC-1(V) steerable antenna array used on surface ships for SATCOM operations is a major problem area. Need for corrective action seems to be indicated for the Scott-Tee card based on Fleet narrative comments. Also, training of AN/WSC-3 operators on the OE-82 mount should be stressed.

6-3 AN/WSC-3 GENERAL.

6-3.1 Although the problems described in paragraph 5-1.2 are not of a magnitude to cause O-Level modules to perform worse than their predicted (piece-parts) MTBF, it is recommended that the modules returned to the repair depot be monitored (1) for significantly high return rate by the structured analysis technique, and (2) for low verification ratios.

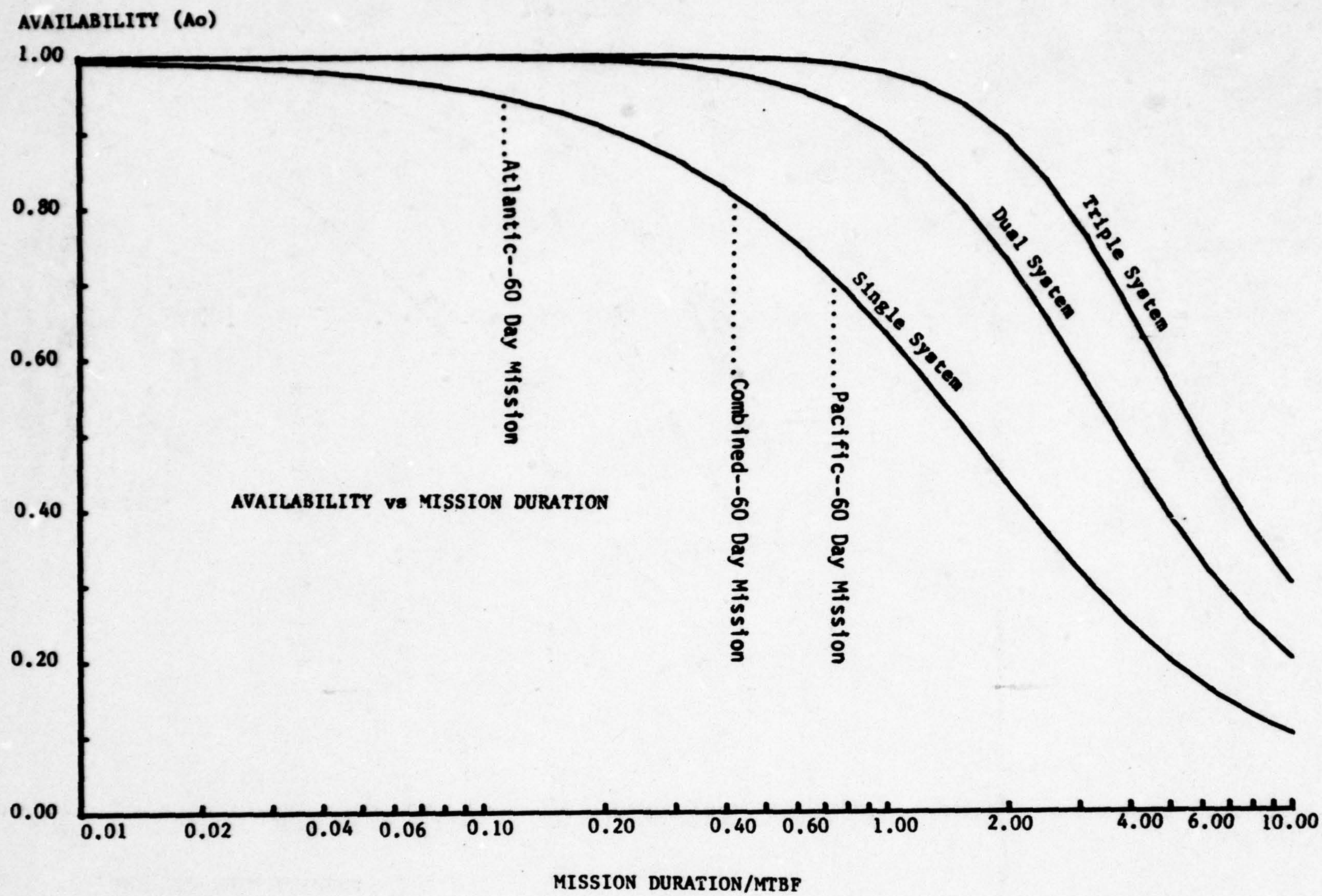
SECTION VII - COST - BENEFITS

7-1 AVAILABILITY

7-1.1 ESTIMATED PACIFIC AND ATLANTIC FLEET. Using the assumed exponential distribution for failure rates and the log-normal distribution for down times for the AN/WSC-3's in the Pacific Fleet, it is estimated that the mean and median availability in the Pacific Fleet is .9355 and .9840, respectively. Then using the assumed exponential distribution for failure rates and the log-normal distribution for down times in the Atlantic Fleet, it is estimated that the mean and median availability in the Atlantic Fleet is .9453 and .9858.

7-1.2 SPARING EFFECT. When an item is vital to the mission, it is often duplicated in dual or even triple installations. Figure 3-7.1 shows the increase in availability obtainable using dual or triple installations. This family of curves could be continued but a diminishing return on investment is already apparent with the third installation. These curves are generalized and apply to any equipment with exponential failure and down time rates. For a 60 day mission of the AN/WSC-3, the greatest potential improvement is shown to be for the Pacific Fleet's equipment due to its lower MTBF.

7-1.3 RMA PARAMETER IMPROVEMENTS EFFECTS. Figure 3-7.2 and Table 3-7.1 addresses the sensitivity of the AN/WSC-3 availability to independent changes in MTBF, MTTR, and MDT. It is readily apparent that availability is much more sensitive to improvements in MTBF and MDT than to improvements in MTTR. Additionally, the magnitude of improvement in availability is similar for the same magnitude of improvement in MTBF and MDT. Improvements in MDT can be made at less cost than improvements in MTBF. The former can be accomplished through optimum use of spares as discussed in Appendix E, FRAP TECHNOTE, ALLOWANCE PARTS LIST OPTIMIZATION: AN/WSC-3 SATELLITE COMMUNICATIONS SET.


AVAILABILITY (Ao)
1.00
0.80
0.60
0.40
0.20
0.00
0.01
0.02
0.04
0.06
0.10
0.20
0.40
0.60
1.00
2.00
4.00
6.00
10.00
MISSION DURATION/MTBF
AVAILABILITY vs MISSION DURATION
.....Atlantic--60 Day Mission
..............Combined--60 Day Mission
.........Pacific--60 Day Mission
Single System
Dual System
Triple System

AVAILABILTIY vs IMPROVEMENT FACTORS
FOR AN/WSC-3 RADIO SET

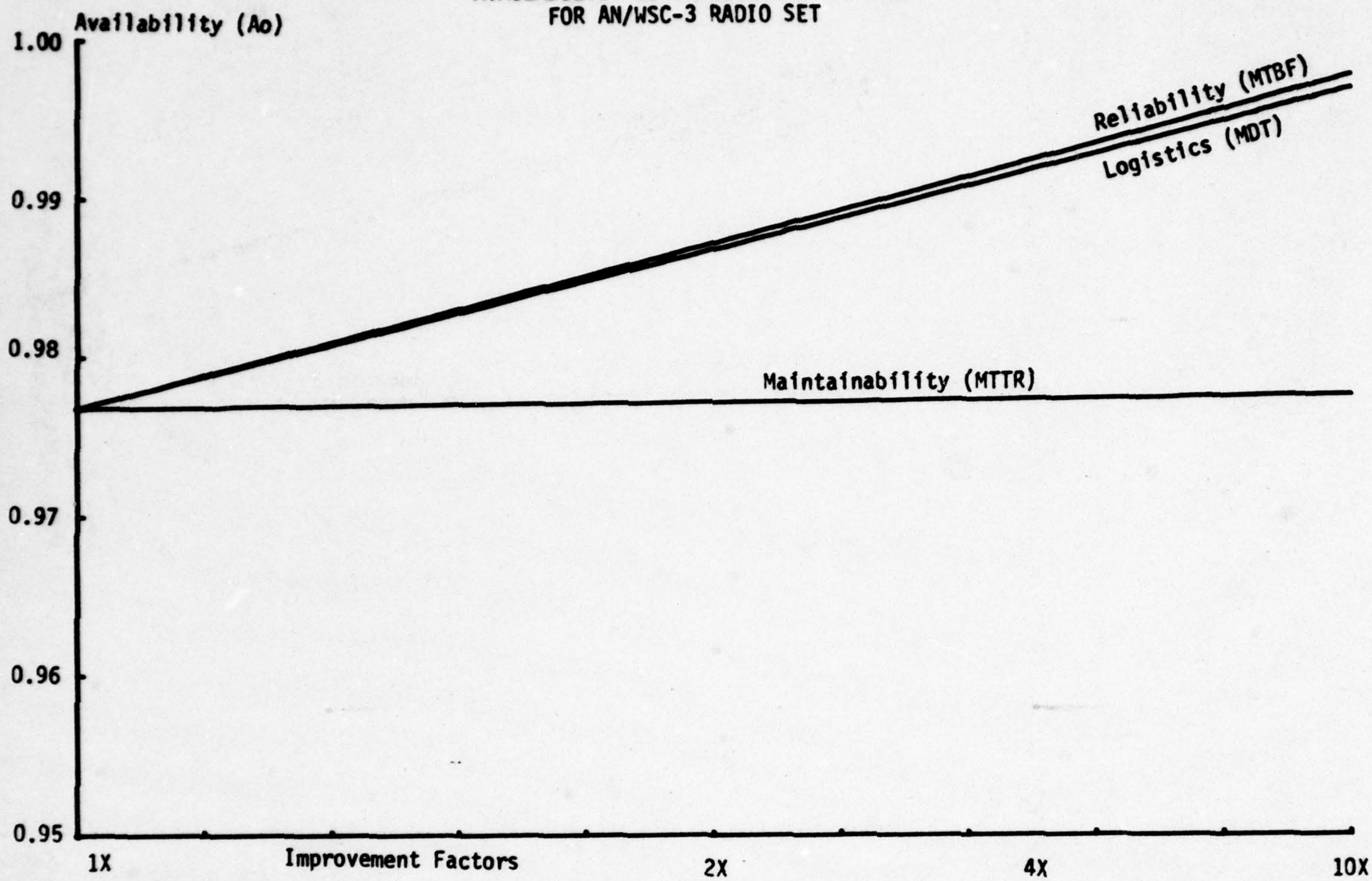


TABLE 3-7.1
AN/WSC-3
OPERATIONAL AVAILABILITY IMPROVEMENT

A_o = MTBF/(MTBF + MDT)

Observed: MTBF = 3770 assuming exponential, MTTR = 4.0 assuming exponential
MDT = 104.1, median DT = 15.2, assuming log-normal.

RELIABILITY IMPROVEMENT

F_I	MTBF	MDT	A_o	U
1	3770	104.1	.973	.027
2	7540	104.1	.986	.014
4	15,080	104.1	.993	.007
10	37,700	104.1	.997	.0024

MAINTAINABILITY IMPROVEMENT

F_I	MTBF	MTTR	MDT	A_o	U
1	3770	4.0	104.1	.973	.027
2	3770	2.0	102.1*	.974	.026
4	3770	1.0	101.1*	.974	.026
10	3770	.4	100.5*	.974	.026

*164.1 - MTTR

LOGISTIC IMPROVEMENT

F_I	MTBF	MTTR	MDT	A_o	U
1	3770	4.0	104.1	.973	.027
2	3770	4.0	54.0*	.986	.014
4	3770	4.0	29.0*	.992	.008
10	3770	4.0	14.0*	.996	.0037

*((104.1-4.0)/F_I) + 4.0

SECTION VIII - SPECIFICATION REQUIREMENTS

8-1 RELIABILITY

8-1.1 ELEX-C-168 COMMUNICATIONS SET, SATELLITE AN/WSC-3, dated 4 December 1973, states in paragrpah 3.2.1, "The set, including built-in-test equipment, shall have a minimum acceptable MTBF (θ_1 as defined by MIL-STD-781) of 1500 hours". In ADDENDUM 2, dated 24 April 1974, in paragraph 4.7.1, this requirement is amplified as follows: "Production reliability testing shall be performed in accordance with Test Plan VIII, Test Level C of MIL-STD-781..." Under Test Plan VIII, the descrimination ratio is 2.0 which makes the specified value, θo = 3,000 hours. The O-Level specified rates used in this report are predicted piece-parts (MIL-HDB-217) rates developed by the manufacturer. Using these rates the predicted MTBF of the system is 2678 hours.

8-2 MAINTAINABILITY

8-2.1 The above specification in paragraph 3.3.1 states, "The equipment shall have an equipment repair time of not more than 10 minutes when corrective maintenance by module replacement is performed". The implication is that fault location, isolation, and troubleshooting time is in addition to the specified module replacement time. "Equipment repair time" (ERT) as referred to in the specification will be taken to mean the median of reported repair times per MIL-E-16400.

SECTION IX - FLEET DATA ANALYSIS

9-1 DATA COLLECTION

9-1.1 During the nine months FRAP data collection period, AN/WSC-3 failure data were reported on OPNAV 4790/2K forms by participating FRAP platforms. Thirty-seven sample equipments were initialized by FRAP teams during the months of June and July 1976 and terminated during April and May 1977. These samples were distributed between the Fleets as follows: 16 samples in the Atlantic on 13 platforms inclusive of aircraft carriers, destroyers, frigates, submarines, and auxiliary craft; 21 samples on 14 platforms in the Pacific inclusive of destroyers, frigates, submarines, and auxiliary craft.

9-2 COMPUTER ANALYSIS.

9-2.1 RMA ANALYSES. These analysis and the computer output are described in Appendices C and D. Basically the outputs consist of:

(1) Graphs showing:

a. The fit of best fitting probability distribution to FRAP observed times.

b. The fit of other distributions tried. These are given for system time-to-failure, repair and down times.

(2) Tabulation of observed data for time-to-failure, repair, and down times.

(3) Observed frequency distribution and associated goodness of fit tests and confidence limits for the above parameters.

(4) Confidence intervals on the O-level parts which failed.

(5) Summaries of 2K froms where problems were detected in either failures or repair time.

(6) Values for inherent and observed (predicted operational) availability.

9-2.2 SUMMARY. These analyses were performed on (1) all the WSC-3's on Atlantic Fleet platforms, and (2) all the WSC-3's on Pacific Fleet platforms; and, all these sample WSC-3's combined. The results of these analyses are summarized in Table 3-9.1

9-2.3 PARAMETER ASSESSMENT. RMA Fleet parameters are discussed below:

(1) RELIABILITY. Presently the Atlantic Fleet's operational MTBF (estimated to be 8620 hours) is significantly greater than the Pacific Fleet's operational MTBF (estimated to be 2092 hours) at the 80% confidence level as illustrated by the non-overlapping confidence intervals. One factor contributing to this difference is the extra learning experience of the Atlantic Fleet. The Atlantic Fleet had the opportunity to use the AN/WSC-3 on a limited use (near end-of-life) satellite before

TABLE 3-9.1
SUMMARY OF COMPUTER ANALYSIS

	ATLANTIC	PACIFIC	COMBINED
Total Equipment Operating Time	77,580	54,385	131,965
Total Equipment Calendar Time	110,445	92,616	203,064
Duty Cycle	.702	.587	.650
No. of Operational Failures	9	26	35
Estimated Operational MTBF	8,620	2,092	3,770*
80% Confidence Interval	5,461-14,281	1,608-2,758	3,008-4,770*
Estimated Median	5,974	1,450	2,613*
Specified MTBF	3,000	3,000	3,000
Predicted (MIL-HDB-217) MTBF	2,678	2,678	2,678
Estimated Operational MTTR	2.2	4.9	4.0
80% Confidence Interval	1.3-2.4	3.7-6.7	3.2-5.2
Estimated Median	1.8	3.4	2.8
Specified Repair Time	.17	.17	.17
Estimated Mean Down Time	168.6	75.2	104.1
80% Confidence Interval	8.4-78.3	6.4-23.0	8.9-21.2
Estimted Median	25.6	12.1	15.3
Estimated Mean Operational Availability	.9453	.9355	.9052
Estimated Median Operational Availability	.9858	.9840	.9839
Estimated Inherent Availability	.9997	.9977	.9992
Specified Inherent Availability	.9999	.9999	.9999

*For Exponential Distribution

SATCOM was launched. The Pacific Fleet acquired satellite access about the time FRAP was implemented. The duty cycle of .702 in the Atlantic and .587 in the Pacific could be reflective of this learning process. When the equipments from the Atlantic and Pacific Fleets are combined, a Weibull distribution with $\beta = .654$ and a mean of 5221 hours is obtained. However, it is believed that this resultant Weibull is due more to the difference between Fleets than a decreasing failure rate. Thus, the exponential estimate of 3770 hours appears to be more appropriate than the Weibull estimate. Even this estimate should be used with caution due to the significant difference of Fleets.

In order to determine whether the Fleet is meeting the specified and predicted MTBF exponential estimates given in Table 3-9.1 must be converted to equipment MTBFs. This is accomplished by using the verification ratio of .86 which is an estimate (based upon depot repair) of proportion of equipment failures contained in the operational failures (paragraph 10-1.3). Using this ratio, the estimated equipments MTBF's for the Atlantic, Pacific, and combined Fleets are 10,023, 2433, and 4384 hours, respectively. With these estimates, the Atlantic and combined Fleets equipment meet the specified MTBF of 3000 hours and the predicted (MIL-HDB-217) MTBF of 2678 hours. However, in order to determine if the Atlantic Fleet's equipment meets these values, the confidence interval given in Table 3-9.1 for the Atlantic Fleet needs to be converted to equipment reliability. Using the verification ratio, the Atlantic Fleet's equipment MTBF is estimated to be between 1870 and 3207 hours. As the specified and MIL-HDB-217 predicted MTBF's are within this interval, the Atlantic Fleets equipment is considered to be meeting these values.

(2) MAINTAINABILITY (REPAIR TIME). The learning curve effect seen in the MTBF values also shows up in the MTTR observations. The Pacific users show an MTTR of 4.9 hours with a median of 3.7 hours. The Atlantic users show an MTTR of 2.4 hours with a median of 1.9 hours. The 90% lower limit on the Atlantic median is about 1.3 hours. In view of the fact that fractional hour repair times are not reported, i.e., the smallest reportable repair interval is one hour, the 1.3 hour median value is judged to be in substantial compliance with the specified 10 minute equipment repair time (ERT). It is expected that the Pacific users of AN/WSC-3 systems will ultimately show maintenance performance levels very similar to that of the Atlantic users.

(3) MAINTAINABILITY (DOWN TIME). The learning curve effect is not readily apparent in the observed down times. The Atlantic Fleet had a mean down time of 168.6 hours with a median down time of 25.6 hours whereas the Pacific Fleet had a lower mean down time of 75.2 hours and a lower median down time of 12.1 hours. However, one reason for the Atlantic having the greater down times is that Atlantic Fleet users originally had a list of replacement modules which was different from the Supply system's list.

(4) AVAILABILITY. The inherent operational availability (MTBF/(MTBF + MTTR)) for both the Atlantic and Pacific Fleets is very near that obtained when using the specified MTBF and repair time. The estimated mean operational availability (mean of TTF/(TTF + DT) ratios) for all WSC-3's in the Atlantic Fleet is .9453 and for the WSC-3's in the Pacific Fleet is .9355. The median for the Atlantic Fleets WSC-3's is .9858 and for the Pacific Fleets WSC-3's the median operational availability is .9840. Thus, the operational availability is similar for both Fleets.

30

9-2.4 PROBLEMS IDENTIFIED. The following modules were indicated as being significant problem areas:

(1) FREQUENCY STANDARD MODULE A1A23. This module is a sealed unit containing a crystal oscillator circuit inside a temperature controlled oven. This oscillator generates the 5MHz reference signal that is used to generate all heterodyne signals used in the radio. This module was not a problem in the Atlantic Fleet (no replacements), but was replaced three times in the Pacific Fleet. Those modules have yet to appear at the depot repair facility.

(2) PHASE SHIFT KEYING TRANSMIT LOGIC MODULE A1A5. The PSK transmit logic module is the formatting section of the transmitter. It has four straps (a kind of simple electrical switch in which a conductive link is used to bridge conductors to select the desired path. Straps are usually held in place by screws) which select the desired modulation options. It is known that some modules reached the Fleet incorrectly strapped. Since the user does not normally switch straps, several of these modules were turned in as faulty. The Atlantic Fleet had no PSK transmit logic failures; the Pacific Fleet had four.

9-3 FLEET NARRATIVE DATA.

9-3.1 GENERAL. The SATCOM system which used the AN/WSC-3 has been very, very favorably received by the operating level Fleet user. Interview comments were overwhelming positive even on platforms that had lengthy delays in getting power level adjustments (see 9-3.2). One FRAP submission from the USS MORTON, DD 948, contains the remark, "WORKS LIKE A CHAMP", which seems to sum up the Fleet's feelings about the AN/WSC-3. This is not to indicate that problems did not occur. For example, a SNAFU resulted in Atlantic users having one list of numbers for replacement modules while the supply system had another; neither had both. Until that was ironed out, Fleet support organizations ran an "underground railroad" in spare modules. The effect of that misunderstanding remains in the supply system computer which (incorrectly) shows virtual no demand for AN/WSC-3 modules for a sizeable part of calender year 1976. Since future sparing levels are determined by a computer algorithm based on past demand, this problem could return to haunt the Fleet at a later time.

9-3.2 POWER LEVELS. The AN/WSC-3 is designed to work on submarines and surface ships in Line-Of-Sight (LOS) mode on a 0db gain antenna. The shipboard trainable antenna has roughly 10db of gain. This extra gain on the transmit end coupled with a less than expected power level tolerance at the receiving end (the satellite) have combined to cause shipboard AN/WSC-3 users considerable problems. At first the radio set would not operate at power levels low enough for satellite use. Modification to the automatic shutdown circuitry allowed operations in the subzero DBW (1 watt into 50 ohms) range with -13 dBW being typical. Coordination problems with the shore-based SATCOM control stations resulted in lengthy delays in setting transmit power levels. Further, the meter on the AN/WSC-3 is inadequate in the range below -10 DBW of output power, since the scale there is highly compressed a small needle movement represents a sizable power shift. When a radio is tested, repaired, or otherwise disturbed, it is difficult to re-establish the proper output. Submittals indicate that the "proper" power setting varies from day to day and

operator to operator at SATCOM Control. Suggestions for improvements have ranged from replacing the power meter with a physically larger unit to providing an additional power range setting on the meter function switch. Some better means of power level indication (even a "Go-No-Go" light at the "proper" level) such that the lengthy adjustment sequences with SATCOM Control can be minimized is definitely required.

9-3.3 TRAINABLE ANTENNA. The trainable array antenna used by the AN/WSC-3 in satellite link operations aboard surface ships has been a major headache to SATCOM users. Although not part of the FRAP field study, Fleet users were as quick to complain about the antenna, a Collins Radio OE-82B assembly, as they were to praise the AN/WSC-3 radio set. The Scott-Tee card in particular was mentioned again and again as a weak link. The user on one platform told FRAP interviewers that they had one Scott-Tee card that worked that they were swapping it between antenna mounts each time the ship turned. Replacement cards for the second mount simply did not stand up. In other cases, it appears that training is a contributing factor to the situation. The technicians are given the impression during AN/WSC-3 schooling that the antenna mount system is simple with nothing to worry about. It is not simple. Accurate estimates of antenna system operational performance parameters are not available since FRAP was not tasked to collect data on it.

SECTION X - ANALYSIS OF DEPOT DATA

10-1 BACKGROUND

10-1.1 The AN/WSC-3 is manufactured by Electronic Communications, Inc., a subsidiary of National Cash Register (NCR) located in St. Petersburg, Florida. Depot repair for AN/WSC-3 modules is conducted at the contractor's facility. A record of those repair actions forms the basis of this analysis.

10-1.2 STRUCTURED ANALYSIS. FRAP has developed a failure ranking technique useful for locating field problems as evidenced by their module return rates. This method takes into account both the numbers of each module used in a system and the complexity of each module. A problem is evidenced by an observed return rate which is significantly larger than the expected return rate. To measure this significance, a Poisson Test of Means is used. The results of this test are expressed in percent and represent the probability that the observed return rates and the expected return rates are truely different, In FRAP, 95% significance (probability) was chosen as the trigger point for followup study.

10-1.3 VERIFICATION RATIO. For each of the 95% + significant module, a verification ratio was calculated using:

$$V = (N_1 + N_2/2)/N$$

where:

N_1 = Number of failures confirmed at depot repair

N_2 = Number of failures not cofirmed at depot repair

$N = N_1 + N_2$ = Total number of resolved fleet failures

This equation states that it is an even chance that an unconfirmed failure did, in fact, malfunction in the Fleet. Verification ratios range between 0.50 and 1.00 with 0.85-0.90 being average. High verification ratios tend to indicate easily located problems such as catastrophic failures, while low verification ratios tend to indicate the presence of some unusual factor such as thermal problems, training or technical manual short comings, or problems in test procedures.

10-2 FINDINGS.

10-2.1 OVERALL. Five modules (four and the chassis) were found to be significant at the 95% + level. These are discussed in the following paragraphs.

10-2.2 CONTROL CONVERTER, MODULE A1A9. The control converter is an interface module that accepts digital information from the remote control box (or a computer) and the front panel. This information is digitally converted into the form and format need by the control circuits of the radio. The control converter is 97.23% significant on 9 returns showing a verification ratio of 0.78, which is low. Transistor designated "Q3" was replaced 5 times. One of the "not verified" repairs noted "updated to revision C". No other pattern is apparent.

10-2.3 AMPLITUDE MODULATION DETECTOR, MODULE A1A15. The AM detector receives the output of the main Intermediate Frequency (IF) amplifier, A1A16, and extracts the AM signal information for output to the audio stages. This module also generates the Automatic Gain Control (AGC) voltages that are used by the receiver front end module, A1A17, and the IF amplifier, A1A16. The AM detector is 97.95% significant on 12 returns showing a verification ratio of 0.96, which is high. Capacitor designated "C23" was replaced five times. Spacers were inserted four times. Two repairs reports contain the phrase "updated to revision G". The capacitor designated "C23" is an interstage coupling capacitor which is protected from excessive voltage spikes by several resistors. It is unlikely that the capacitor is failing from overstress. A materials problem is indicated.

10-2.4 MAIN INTERMEDIATE FREQUENCY AMPLIFIER MODULE A1A16. The main IF amp provides the bulk of the signal amplification and filtering in the radio set. This module is actually two IF amplifiers, a wide band and a narrow band unit. One or the other is disabled by control signals. The IF module also performs signal blanking under control of the blanking module, A1A17. The IF module is 98.91% significant on 12 returns showing a verification ratio of 0.83, which is average. There are four cases of the replacement of filter "FL-2", a narrow band bandpass crystal filter manufactured by ECI. Twice the comment was made, "open", which could indicate a catastrophic failure, such as a crystal fracture, or the shift of the pass band such that the IF signal no longer can pass through. No other pattern is apparent.

10-2.5 DATA BUFFER MODULE A1A19. The data buffer provides amplification, signal control, and level conversion for the output Frequency Shift Keyed (FSK) or Phase Shift Keyed (PSK) data and clock signals. The data buffer is 99.99% significant on 8 returns showing a verification ratio of 0.75, which is very low. Microcircuit "U4", a quad 2 input NAND gate was replaced 3 times for crosstalk. The schematic shows U4 as handling (through separate gates) the receive clock, the transmit clock, and received data. It is noted that the three U4 replacements also contained the note "Revision B", which is taken as an indication that the problem has been recognized and a fix formulated. No other pattern is apparent.

10-2.6. CHASSIS. The chassis includes the metal box, connectors, cables, etc. that are required to physically support and electrically interconnect the other modules. The chassis is 100% significant on one failure showing a verification ratio of 0.50. The failure was not confirmed.

10-3 <u>FAILURE ANLAYSIS</u> .

10-3.1 A1A5C23 AND A1A5C26. Capacitors C23 and C26 from PSK transmit logic module serial number B-49 taken from the USS MONTICELLO, LSD-35, are Sangamo type CMR4E-680J0. Visual examination shows the leads to be broken off adjacent to the molded case (see Figure 3-10.1). The capacitors passed electrical tests and were deemed to be good. The leads were broken as a result of mechanical over stress.

10-3.2 A1A15C22, A1A15C23, AND A1A15C24. Capacitors C22, C23, and C24 from the AM detector module in AN/WSC-3 serial number B-144 aboard the USS HAWKBILL, SSN 666, are Westcap .0015 UF 50V type 74J0J152-3 units. The complaint was, "can not set squelch". The depot repair technician commented, "can not verify customer's reject

but (am) changing C22, C23, and C24. This is a common intermittent problem. ECI has changed vendors to correct the problem." The capacitors looked good visually, checked good on X-ray, tested good at 50V and 200V with no intermittent opens or shorts, and were deemed to be good. (See Figure 3-10.1).

10-3.3 RELAY A1A1K1. AN/WSC-3 serial number B219 failed with the following complaint: "will not transmit data". An armature relay manufactured by ECI was found defective and was replaced. Electrical tests showed a failure at pins B1, B2 and B3. Removal of the case disclosed welded contacts between pins B2 and B3. The type of melting observed (see Figure 3-10.2) required an estimated 5 amperes of current, which is a gross overload for this relay.

10-3.4 MICROCIRCUIT A1A8U1. AN/WSC-3 serial number B144 aboard the USS HAWKBILL, SSN 666, failed with the complaint, "Incorrect frequency output from synthesizer A1A8". Depot repair isolated the problem to the frequency scaler board and replaced the microcircuit designated "U1", manufactured by Collins Radio Company with part number 72-00141-001. This microcircuit is a hybrid film circuit on a ceramic substrate using monolithic integrated circuits ("chips") bonded to the substrate with epoxy and interconnected using hair-fine wires. The resulting hybrid circuit performs a divide-by-five frequency scaling function. The microcircuit failed electrical tests. After de-lidding (see Figure 3-10.3), visual examination disclosed a wire bond failure on pin 5 (see Figure 3-10.4). Electrical tests showed the microcircuit to be fully functional with pin 5 by- passed. Bond pull strength tests on other pins were good. The bond defect on pin 5 was judged to be the cause of the microcircuits failure. It was further judged that the failure was a chance occurrence as the bonding technique employed resulted in acceptable bonds on other pin posts.

10-3.5 CAPACITOR A1A8C9. During depot trouble shooting of the microcircuit problem detailed in section 10-3.4 above, depot repair also replaced capacitor C9 in the phase detector. This capacitor tested good at room temperature. The potting was removed, revealing a loose connection; the silver end cap had separated from the ceramic dielectric, see Figure 3-10.5. This kind of failure is common and is a result of improper process control and cleaning during manufacture. Although not observed at room temperature, electrical intermittents (opens) result from such bond failures. It was concluded that capacitor C9 was defective in manufacture and was probably intermittent in circuit performance.

10-3.6 TRANSISTOR A1A3Q2. AN/WSC-3 serial number B-125 aboard the USS HOEL, DDG-13, failed with the complaint, "No integrator balance". Depot repair of the receiver phase shift logic module from this set found Q2, a JAN 2N2907A transistor manufactured by National Semiconductor, to be shorting in the circuit. Analysis of Q2 showed very high leakage from collector to base during electrical tests. Examination by scanning electronic microscope after de-lidding revealed an overly long base bonding wire which was touching the edge of the chip common to the collector, see Figure 3-10.6. This type of failure is a workmanship defect which might have been screened out during visual inspection if the part had received JANTXV processing.

10-4 SUMMARY.

10-4.1 Neither of the problem modules found from the FRAP field study showed significance on depot data analysis and none of the four significant problem modules from depot analysis were identified as current problems in the Fleet. It was discovered that incoming inspection at depot repair was pulling and discarding the user submitted reason for return form. This was causing the repair technician to work blind and lowered the verification ratios on certain complex or marginal modules. As a result of gathering information for the FRAP study, this practice was found and halted. The repair technician now receives the Fleet user's comments accompanying the failed part.

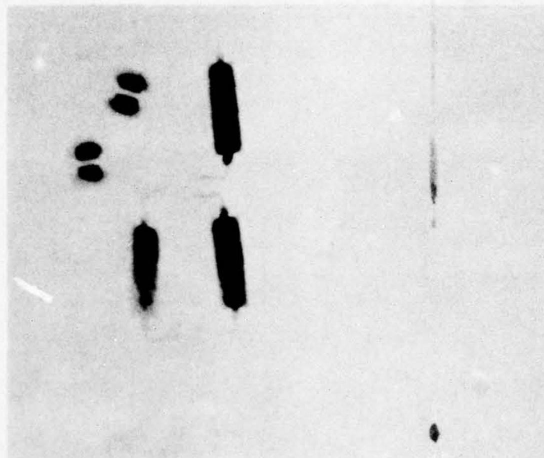


Figure 3-10.1 Xray of Capacitors

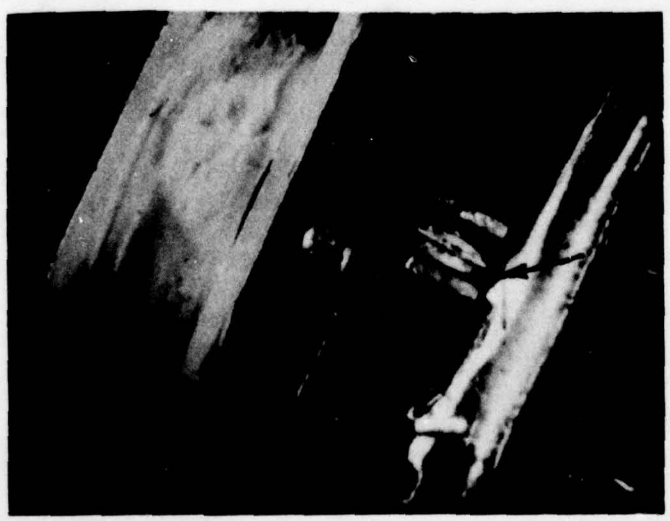


Figure 3-10.2 Relay (P/N 47-00184) From Transmitter Module 1A1A1

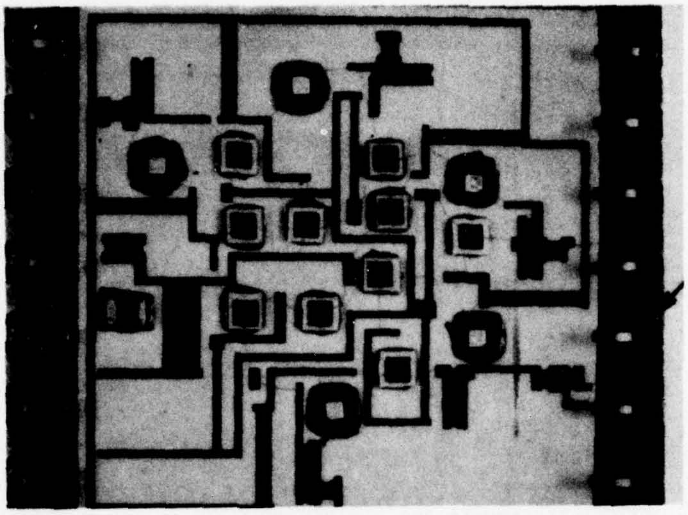


Figure 3-10.3 Hybrid Microcircuit (U1) From Synthesizer A1A8

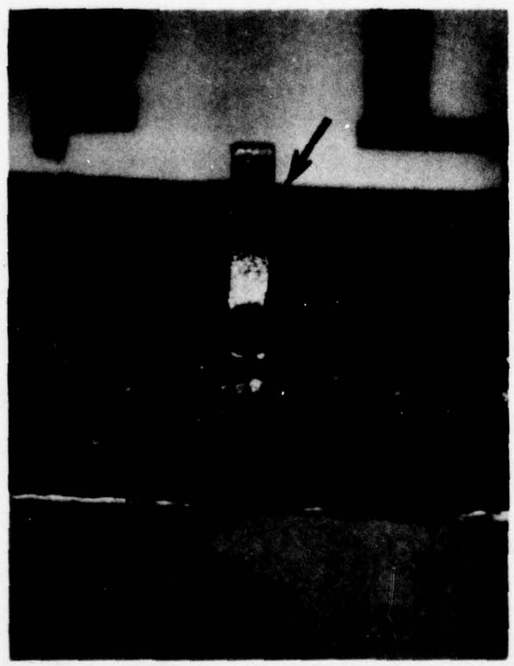


Figure 3-10.4 Enlargement of Pin 5 of Microcircuit U1 Above

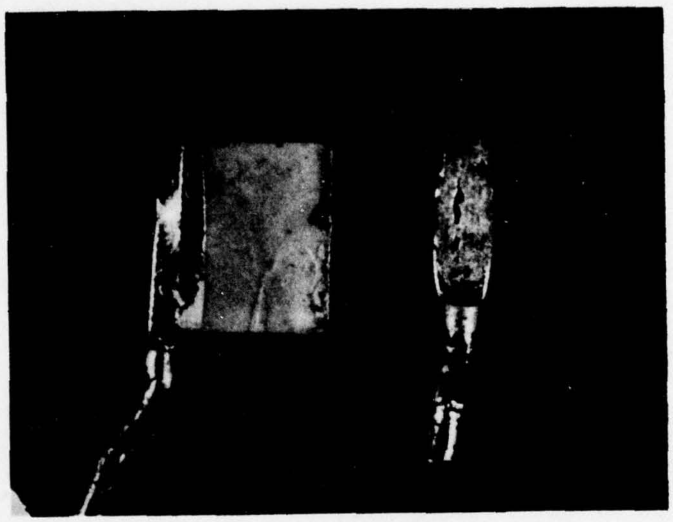
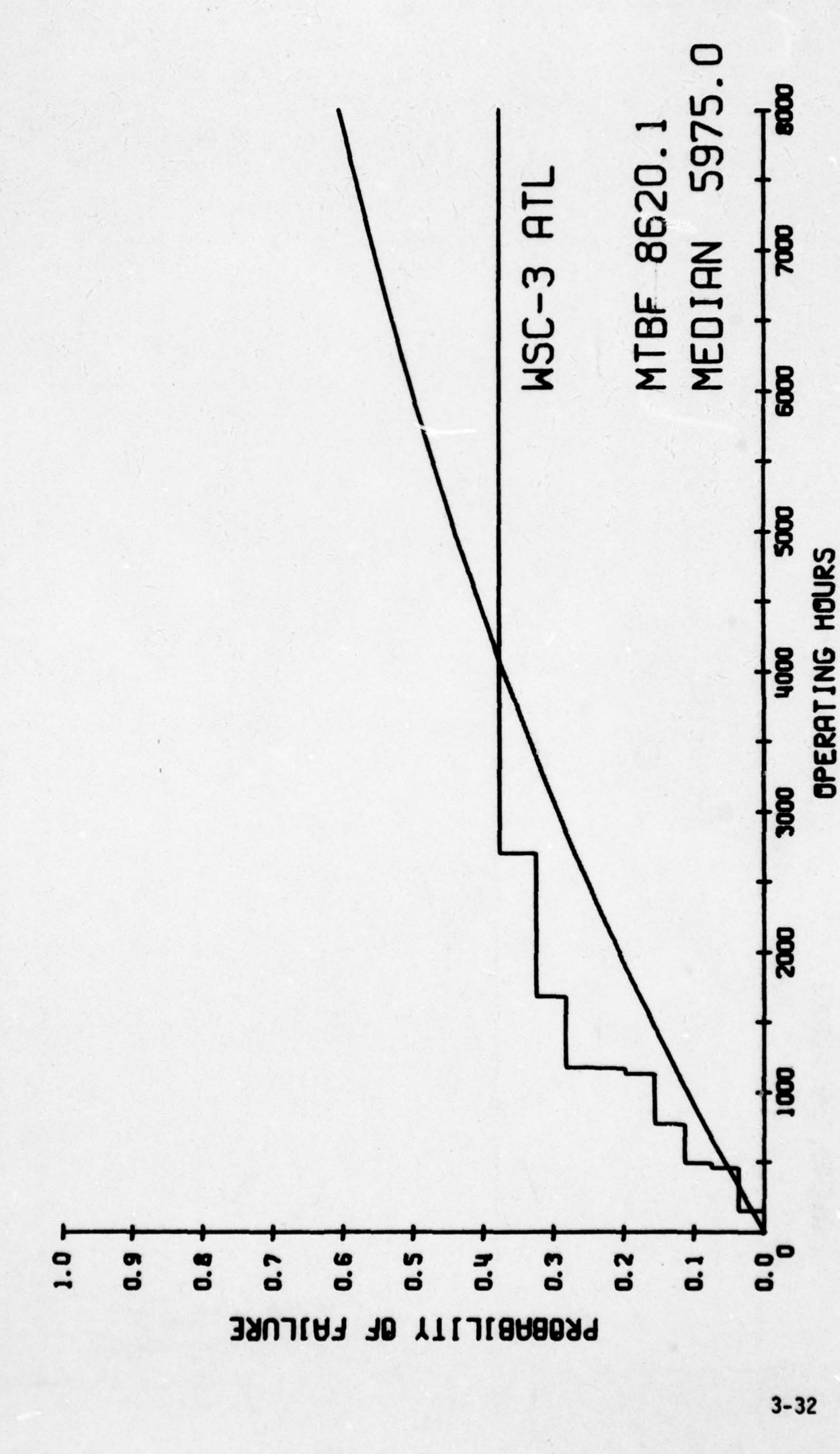


Figure 3-10.5 Capacitor (C9) From Phase Detector Section of A1A8

Figure 3-10.6 Transistor (Q2) From Phase Shift Logic Module. Note Base Lead Touching Substrate (Collector Region)

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		ARA	OL1	OL2	OL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
0	6181	0	0	0	0	0	1365.1	0.0	0.0	0.0	0.000	0.0	2	33681	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	6884.0	6884.0	5518.9	.970	5518.9	2	33681		
4	7090	7090	0	0	0	0	0.0	7748.5	7748.5	6383.4	.971	6383.4	2	33681		
0	6181	0	0	0	0	0	2345.0	0.0	0.0	0.0	0.000	0.0	2	33682	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	7863.0	7863.0	5518.0	.970	5518.0	2	33682		
4	7090	7090	0	0	0	0	0.0	8725.8	8725.8	6380.8	.970	6380.8	2	33682		
0	6181	0	0	0	0	0	499.0	0.0	0.0	0.0	0.000	0.0	2	33683	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	6019.0	6019.0	5520.0	.970	5520.0	2	33683		
4	7090	7090	0	0	0	0	0.0	6881.1	6881.1	6382.1	.971	6382.1	2	33683		
0	6181	0	0	0	0	0	364.5	0.0	0.0	0.0	0.000	0.0	2	33684	NIMITZ	CV 68
3	6252	6252	1	22	0	0	0.0	2052.0	2052.0	1657.5	.990	1687.5	2	33684		
6	6354	6354	1	12	0	0	0.0	4759.6	4759.6	4395.1	1.059	2707.6	2	33684		
8	7053	7053	0	0	0	0	0.0	5252.0	5252.0	4887.5	.859	492.4	2	33684		
4	7090	7090	0	0	0	0	0.0	5420.6	5420.6	5056.1	.769	661.0	2	33684		
0	6159	0	0	0	0	0	2302.9	0.0	0.0	0.0	0.000	0.0	2	46680	ADAMS,CHARLES	DDG 2
3	6209	6211	1	5	0	0	3087.2	3084.9	3087.2	782.0	.627	782.0	2	46680		
4	7084	7084	0	0	0	0	0.0	8438.5	8438.5	6133.3	.881	5351.3	2	46680		
0	6154	0	0	0	0	0	2403.1	0.0	0.0	0.0	0.000	0.0	2	46980	PAGE,RICHARD L	FFG 5
3	6194	6196	1	9	0	0	0.0	3544.1	3544.1	1141.0	1.132	1141.0	2	46980		
8	7098	7098	0	0	0	0	0.0	9576.0	9576.0	7172.9	.967	6031.9	2	46980		
4	7115	7115	0	0	0	0	0.0	9989.4	9989.4	7586.3	.970	6445.3	2	46980		
0	6155	0	0	0	0	0	1219.1	0.0	0.0	0.0	0.000	0.0	2	46990	FURER,JULIUS A	FFG 6
3	6162	6188	1	18	0	0	1720.0	1720.0	1729.0	500.9	.632	500.9	2	46990		
8	6265	6265	0	0	0	0	0.0	3081.8	3081.8	1853.7	.702	1352.8	2	46990		
4	7082	7082	0	0	0	0	0.0	7231.1	7231.1	6003.0	.857	5502.1	2	46990		
0	6159	0	0	0	0	0	531.5	0.0	0.0	0.0	0.000	0.0	2	51450	SEA DEVIL	SSN 664
4	7087	7087	0	0	0	0	0.0	2797.1	2797.1	2265.6	.322	2265.6	2	51450		
NO INITIAL RECORD-FIRST RECORD USED																
4	7116	7116	0	0	0	0	4779.6	4779.6	4779.6	0.0	0.000	0.0	2	51460	NARWHAL	SSN 671
0	6159	0	0	0	0	0	1230.0	0.0	0.0	0.0	0.000	0.0	2	51520	FINBACK	SSN 670
4	7101	7101	0	0	0	0	0.0	5117.4	5117.4	3887.4	.528	3887.4	2	51520		
NO INITIAL RECORD-FIRST RECORD USED																
4	7083	7083	0	0	0	0	3463.1	3463.1	3463.1	0.0	0.000	0.0	2	51540	FLYING FISH	SSN 673
0	6155	0	0	0	0	0	1102.2	0.0	0.0	0.0	0.000	0.0	2	58500	MILWAUKEE	AOR 2
6	6196	6226	1	999	0	0	0.0	1258.0	1258.0	155.8	.091	155.8	2	58500		
4	7073	7073	0	0	0	0	0.0	5131.0	5131.0	4028.8	.593	3873.0	2	58500		
0	6155	0	0	0	0	0	1040.1	0.0	0.0	0.0	0.000	0.0	2	71940	CORONADO	LPD 11
4	7081	7081	0	0	0	0	0.0	5981.4	5981.4	4941.3	.708	4941.3	2	71940		
NO INITIAL RECORD-FIRST RECORD USED																
4	7081	7081	0	0	0	0	9954.3	9954.3	9954.3	0.0	0.000	0.0	2	73520	GUADALCANAL	LPH 7
0	6155	0	0	0	0	0	601.4	0.0	0.0	0.0	0.000	0.0	2	200190	MANITOWOC	LST1180
3	6229	6231	1	5	0	0	1068.0	1068.0	1068.0	466.6	.256	466.6	2	200190		
8	7049	7049	0	0	0	0	0.0	3170.0	3170.0	2568.6	.413	2102.0	2	200190		
4	7073	7073	0	0	0	0	0.0	3477.6	3477.6	2876.2	.423	2409.6	2	200190		
0	6159	0	0	0	0	0	1309.1	0.0	0.0	0.0	0.000	0.0	2	200440	BATFISH	SSN 681
3	6253	6253	1	18	0	0	0.0	2490.0	2490.0	1180.9	.523	1180.9	2	200440		
4	7081	7081	0	0	0	0	0.0	3261.8	3261.8	1952.7	.283	771.8	2	200440		
0	6159	0	0	0	0	0	1104.1	0.0	0.0	0.0	0.000	0.0	2	521970	DAVIS	DD 937
8	6184	6184	0	0	0	0	0.0	1697.2	1697.2	593.1	.989	593.1	2	521970		
3	6209	6210	1	999	0	0	2290.6	2290.6	2293.0	1186.5	.969	1186.5	2	521970		

FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		MRA	OL1	OL2	OL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
4	7082	7082	0	0	0	0	0.0	6777.8	6777.8	5671.3	.821	4484.8	2	521970		
0	6159	0	0	0	0	0	5337.0	0.0	0.0	0.0	0.000	0.0	2	521980	INGRAM, JONAS	DD 938
4	7119	7119	0	0	0	0	0.0	7609.0	7609.0	2272.0	.291	2272.0	2	521980		
0	6155	0	0	0	0	0	2606.1	0.0	0.0	0.0	0.000	0.0	2	522000	DUPONT	DD 941
4	7031	7031	0	0	0	0	0.0	8366.3	8366.3	5760.2	.996	5760.2	2	522000		

R E L I A B I L I T Y

WSC-3 ATL SYSTEM LEVEL

TIME TO FAIL	NO. FAILURES	NO. CENSORED	SURVIVORS	CPDF	EXPONENTIAL	MAX DIFFERENCE
155.8	1.		25.	.038	.018	.021
466.6	1.		24.	.077	.053	.024
500.9	1.		23.	.115	.056	.059
661.0		1.				
771.8		1.				
782.0	1.		20.	.158	.087	.071
1141.0	1.		19.	.200	.124	.076
1180.9	1.		18.	.242	.128	.114
1186.5	1.		17.	.284	.129	.155
1687.5	1.		16.	.326	.178	.148
2265.6		1.				
2272.0		1.				
2409.6		1.				
2707.6	1.		12.	.378	.270	.108
3873.0		1.				
3887.4		1.				
4484.8		1.				
4941.3		1.				
5351.3		1.				
5502.1		1.				
5760.2		1.				
6380.8		1.				
6382.1		1.				
6383.4		1.				
6445.3		1.				

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                              R E L I A B I L I T Y
                              *SC-3 ATL  SYSTEM LEVEL
EQUIPMENT OPERATING HOURS (O.H.) = 77580.5    CALENDAR HOURS(C.H.) =, 110448.0   DUTY CYCLE (O.H./C.H.) =     .702
NUMBER OF FAILURES =  9.    OBSERVED FAILURE RATE/O.H. =  .11601E-03
DISTRIBUTION DETERMINATION,
K-S CRITICAL VALUE ( .10, 9.) =    .311
MAX DIFF CALC =   .155, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED
FOR THE ASSUMED DISTRIBUTION
EST. MEAN =  8620.056,    EST. MEDIAN =  5974.967,    90 PER CENT LCL FOR MEAN =     5461.1,    90 PER CENT UCL FOR MEAN =  14280.941
90 PERCENT UCL    14280.94 IS GREATER THAN     3000.00 HOURS, THEREFORE THE EQUIPMENT MEETS THE SPECIFICATIONS
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R E L I A B I L I T Y

WSC-3 ATL   O-LEVEL SUMMARY

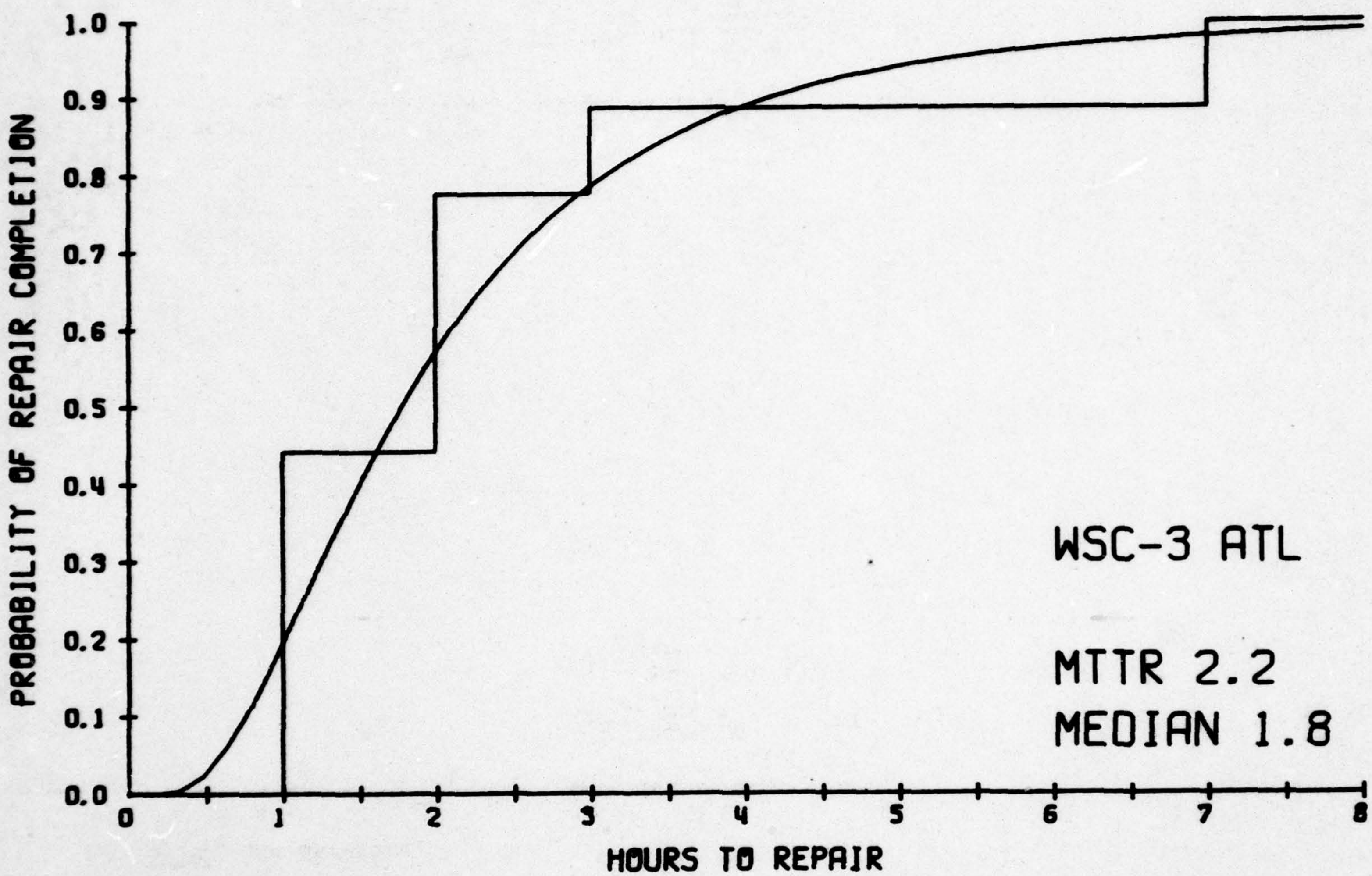
WRA	O-LEVEL BLOCK NO.		O-LEVEL NOMENCLATURE	NUMBER FAILURES	LOWER 90 CONF LIM	MEAN	UPPER 90 CONF LIM	SPEC MTBF	OBSERVED FAILURE TIMES LOW	OBSERVED FAILURE TIMES HIGH	RELIAB PROBLEM
1	5	A1A8	SYNTHESIZER	2.	14576.50	38790.25	145879.70	31025.00	466.60	782.00	NO
1	9	A1A1	EXCITER / PA	1.	19945.01	77580.50	736337.32	15533.00	1141.00	1141.00	NO
1	12	A1A22	VOLTAGE CONTROLLED OSCILLATOR	1.	19945.01	77580.50	736337.32	71608.00	4395.10	4395.10	NO
1	18	A1A7	PSK DETECTOR	2.	14576.50	38790.25	145879.70	30056.00	500.90	1180.90	NO
1	22	A1A3	PSK RECEIVE LOGIC	1.	19945.01	77580.50	736337.32	96414.00	1687.50	1687.50	NO
1	999			2.	14576.50	38790.25	145879.70	2000000.00	155.80	1186.50	YES

R E L I A B I L I T Y

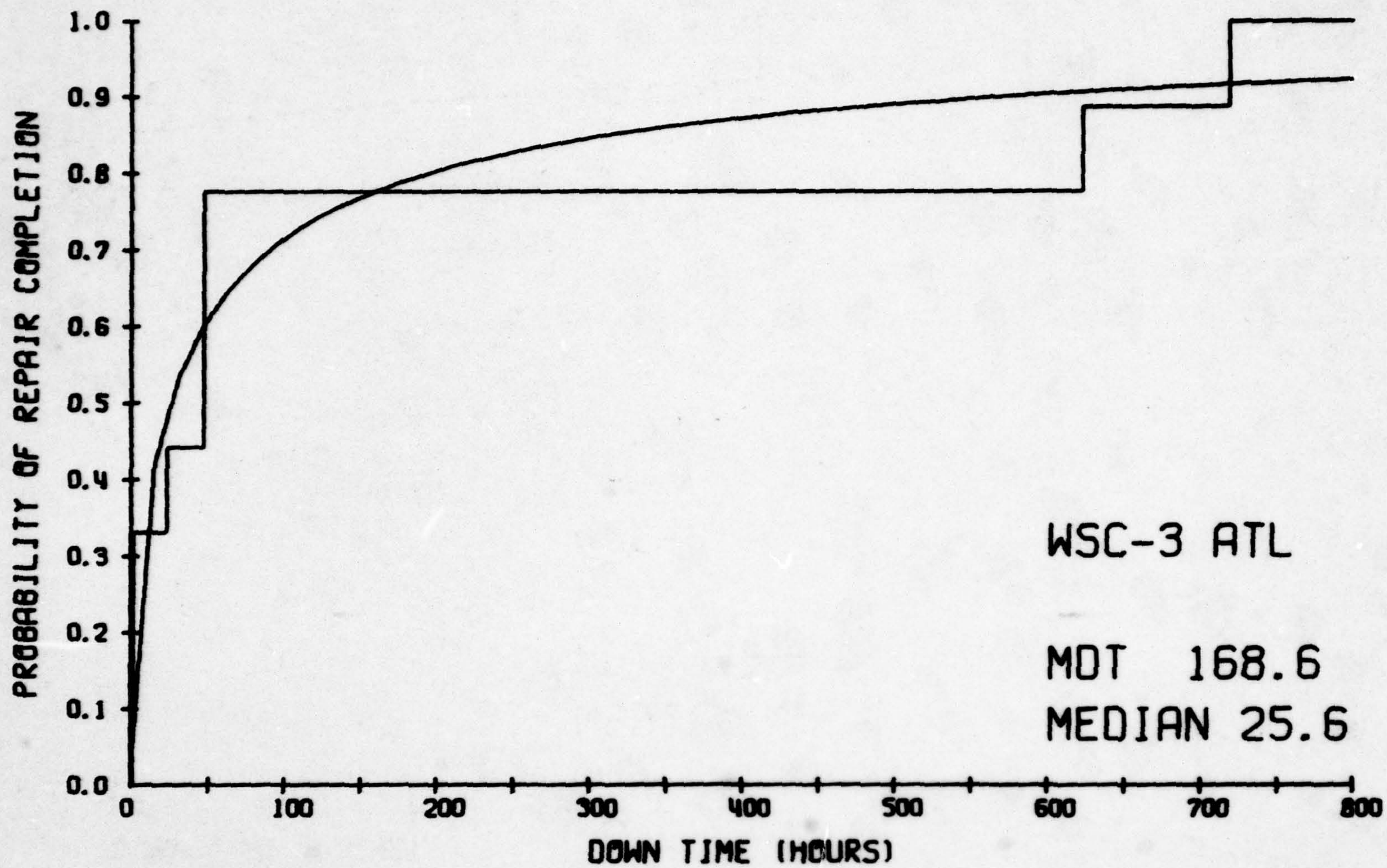
2K SUMMARY FOR WSC-3 ATL PROBLEM AREAS

JCN	SYSTEM	WRA	O-L	O-L	O-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
05850DE01M132	2	1	999	0	0	NO CPY FSK	BITE 22	
52197DE01M164	2	1	999	0	0	NO RCV	SW 16	CHG CABLE STRAP

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR DOWN TIME



FLEET MAINTAINABILITY ASSESSMENT DATA

WRA	DL1	DL2	DL3	DISCOVERY DATE	COMPLETION DATE	DOWN TIME (HRS)	REPAIR TIME (HRS)	SYS	UIC
1	22	0	0	6252	6252	2.0	2.0	2	03368
1	12	0	0	6354	6354	1.0	1.0	2	03368
1	5	0	0	6209	6211	48.0	2.0	2	04668
1	9	0	0	6194	6196	48.0	1.0	2	04698
1	18	0	0	6162	6188	624.0	7.0	2	04699
1	999	0	0	6196	6226	720.0	1.0	2	05850
1	5	0	0	6229	6231	48.0	1.0	2	20019
1	18	0	0	6253	6253	2.0	2.0	2	20044
1	999	0	0	6209	6210	24.0	3.0	2	52197

50

MAINTAINABILITY (REPAIR TIME)

WSC-3 ATL   SYSTEM LEVEL

REPAIR TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	4.	4.0	.400	.195	.205
2.0	3.	7.0	.700	.574	.174
3.0	1.	8.0	.800	.788	.088
7.0	1.	9.0	.900	.981	.181

TOTAL REPAIR HOURS = 20.0   NUMBER OF REPAIRS = 9.   OBSERVED REPAIR RATE/HR = .4500E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .57   STD DEV OF LN'S = .66

K-S CRITICAL VALUE (.10, 9.) = .249   MAX DIFF CALC = .205 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 2.22   EST MEDIAN = 1.77   90 PER CENT LCL ON MEDIAN = 1.30   90 PER CENT UCL ON MEDIAN = 2.41

SPECIFIED MTTR = .17 HOURS   LOWER CONF LIM 1.30 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (DOWN TIME)

WSC-3 ATL   SYSTEM LEVEL

DOWN TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	1.	1.0	.100	.088	.012
2.0	2.	3.0	.300	.144	.156
24.0	1.	4.0	.400	.489	.189
48.0	3.	7.0	.700	.603	.203
624.0	1.	8.0	.800	.908	.208
720.0	1.	9.0	.900	.918	.118

TOTAL DOWN TIME (TDT) = 1517.0   NUMBER OF REPAIRS (NR) = 9.   OBSERVED DOWN TIME/REPAIR (TDT/NR) = 168.56

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 3.24   STD DEV OF LN'S = 2.40

K-S CRITICAL VALUE (.10, 9.) = .249   MAX DIFF CALC = .208 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 168.56   EST MEDIAN = 25.63   90 PER CENT LCL ON MEDIAN = 8.39   90 PER CENT UCL ON MEDIAN = 78.32

MAINTAINABILITY (REPAIR TIME)

WSC-3 ATL O-LEVEL SUMMARY

WRA	O-LEVEL BLOCK NO.		O-LEVEL NOMENCLATURE	NUMBER REPAIRS	LOWER 90 CONF LIM	UPPER 90 CONF LIM	SPEC MTTR	OBSERVED REPAIR TIMES LOW	MEAN	HIGH	MAINT PROBLEM
1	5	A1A8	SYNTHESIZER	2.	.49	4.11	.2	1.0	1.50	2.0	YES
1	9	A1A1	EXCITER / PA	1.	NO CONF LIMITS		.2	1.0	1.00	1.0	
1	12	A1A22	VOLTAGE CONTROLLED OSCILLATOR	1.	NO CONF LIMITS		.2	1.0	1.00	1.0	
1	18	A1A7	PSK DETECTOR	2.	.54	25.73	.2	2.0	4.50	7.0	YES
1	22	A1A3	PSK RECEIVE LOGIC	1.	NO CONF LIMITS		.2	2.0	2.00	2.0	
1	999			2.	.32	9.39	.2	1.0	2.00	3.0	YES

MAINTAINABILITY (REPAIR TIME)

2K SUMMARY FOR WSC-3 ATL   PROBLEM AREAS

JCN	SYSTEM	WRA	O-L	O-L	O-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
03368OE021386	2	1	22	0	0	FAULT LITE	BITE	REPL LOGIC MODULE
03368OE021552	2	1	12	0	0	NO XMT/RCV	BITE 5	REPLACED VCO
04668OE01C081	2	1	5	0	0	DATA BK UP	NONE	REPLACED SYNTH
04698OE01A782	2	1	9	0	0	NO XMT	NONE	RPL XMTR MOD
04699OE21A321	2	1	18	0	0	NO DET PSK	NONE	RPL PSK DET
05850OE01M132	2	1	999	0	0	NO CPY FSK	BITE 22	
20019OE011232	2	1	5	0	0	XMT FREQ BA	D NONE	RPL SYNTHESIZER
20044OC010170	2	1	18	0	0	NO RCV PSK	NONE	RPL PSK DET
52197OE01M164	2	1	999	0	0	NO RCV	SW 16	CHG CABLE STRAP

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                         RMA SUMMARY WSC-3 ATL    SYSTEM LEVEL
TTF DISTRIBUTION IS EXPONENTIAL WITH MEAN =    8620.10
DT  DISTRIBUTION IS LOGNORMAL WITH MEAN OF LNS  =    3.24000 AND STANDARD DEVIATION OF LNS  =    2.40000
RT  DISTRIBUTION IS LOGNORMAL WITH MEAN OF LNS  =     .57000 AND STANDARD DEVIATION OF LNS  =     .66000
            INHERENT AVAILABILITY = MTBF/(MTBF+MTTR)
MEAN TIME TO FAILURE  =   8620.10
MEAN REPAIR TIME      =      2.18
INHERENT AVAILABILITY =     .9997
            OBSERVED AVAILABILITY (SIMULATION OF RATIOS  TTF/(TTF+DT))
90 PERCENT LCL ON INDIVIDUALS =     .8485
90 PERCENT UCL ON INDIVIDUALS =     .9972
MEAN                          =     .9453
MEDIAN                        =     .9858
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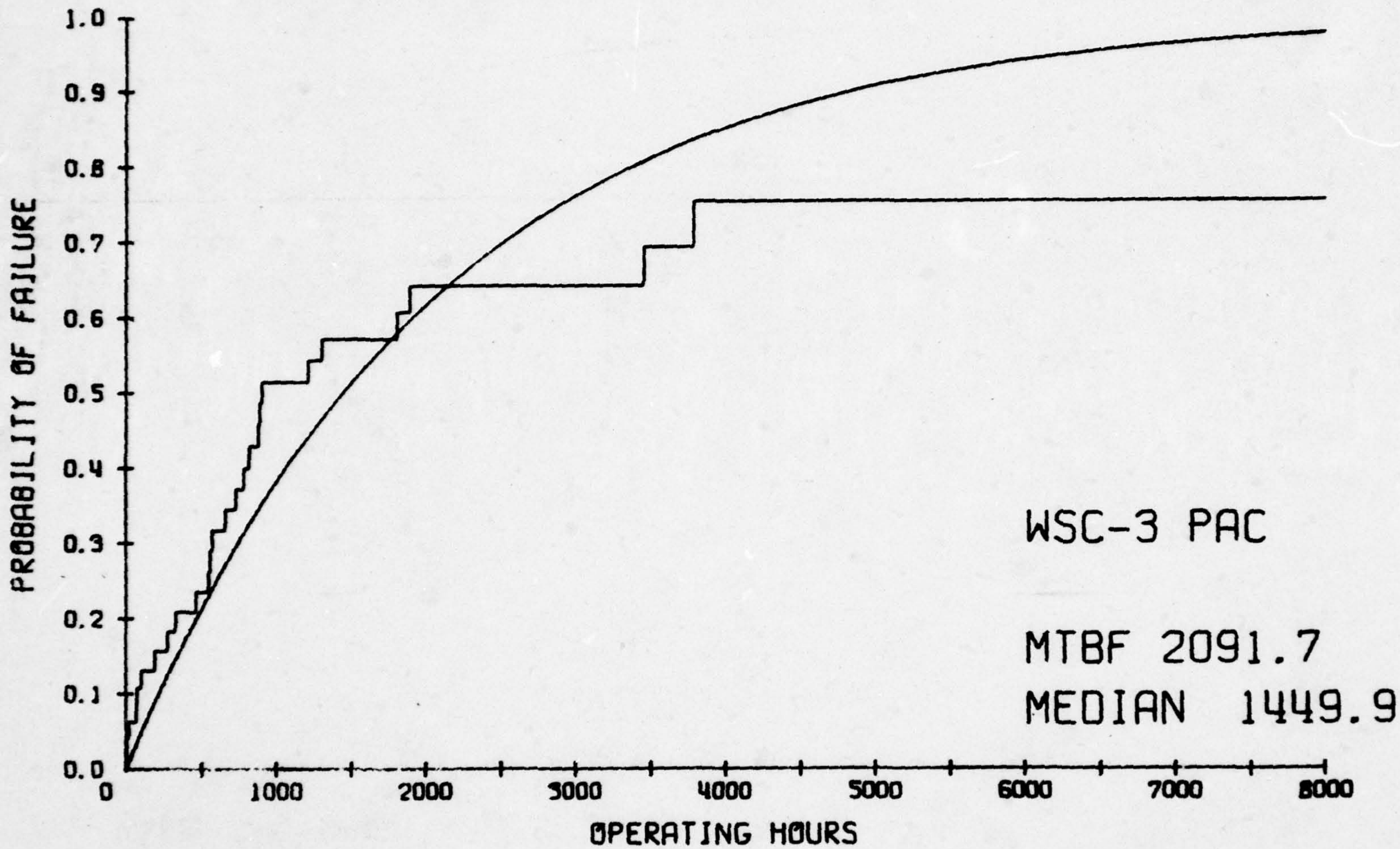
CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		NRA	OL1	OL2	OL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
0	6153	0	0	0	0	0	1412.2	0.0	0.0	0.0	0.000	0.0	2	31350	MONTICELLO	LSD 35
3	6198	6198	1	23	0	0	0.0	2325.5	2325.5	913.3	.846	913.3	2	31350		
4	7072	7072	0	0	0	0	0.0	5905.9	5905.9	4493.7	.659	3580.4	2	31350		
0	6155	0	0	0	0	0	551.3	0.0	0.0	0.0	0.000	0.0	2	46630	SOMERS	DDG 34
3	6258	6258	1	1	0	0	1870.9	1865.9	1870.9	1314.6	.532	1314.6	2	46630		
3	6268	6268	1	9	0	0	1745.4	1945.4	1946.6	1389.1	.512	74.5	2	46630		
3	7060	7061	1	999	0	0	0.0	5742.3	5742.3	5184.8	.797	3795.7	2	46630		
4	7084	7084	0	0	0	0	0.0	5771.2	5771.2	5213.7	.739	28.9	2	46630		
0	6155	0	0	0	0	0	2122.0	0.0	0.0	0.0	0.000	0.0	2	46640	MORTON	DD 948
3	6194	6195	1	6	0	0	2951.0	2951.4	2961.5	829.4	.864	829.4	2	46640		
8	6258	6256	0	0	0	0	0.0	4266.8	4266.8	2134.7	.864	1305.3	2	46640		
4	7087	7087	0	0	0	0	0.0	8903.6	8903.6	6771.5	.950	5942.1	2	46640		
0	6153	0	0	0	0	0	1340.0	0.0	0.0	0.0	0.000	0.0	2	46790	HOEL	DDG 13
6	6169	6169	1	4	0	0	0.0	1674.7	1674.7	334.7	.872	334.7	2	46790		
3	6177	6183	1	5	0	0	0.0	1874.4	1874.5	534.4	.742	199.7	2	46790		
3	6205	6229	1	22	1	0	0.0	2440.0	2513.0	1099.9	.603	565.5	2	46790		
3	6256	6264	1	23	0	0	0.0	3403.0	3404.0	1989.9	.747	890.0	2	46790		
8	6274	6274	0	0	0	0	0.0	3793.3	3793.3	2379.2	.819	389.3	2	46790		
8	6293	6293	0	0	0	0	0.0	4227.0	4227.0	2812.9	.837	823.0	2	46790		
8	6315	6315	0	0	0	0	0.0	4756.1	4756.1	3342.0	.860	1352.1	2	46790		
8	6344	6344	0	0	0	0	0.0	5466.5	5466.5	4052.4	.884	2062.5	2	46790		
8	6355	6355	0	0	0	0	0.0	5730.7	5730.7	4316.6	.890	2326.7	2	46790		
8	7040	7040	0	0	0	0	0.0	6930.9	6930.9	5516.8	.912	3526.9	2	46790		
4	7071	7071	0	0	0	0	0.0	7624.1	7624.1	6210.0	.914	4220.1	2	46790		
0	6153	0	0	0	0	0	642.4	0.0	0.0	0.0	0.000	0.0	2	46910	WADDELL	DDG 24
3	6246	6246	1	18	0	0	0.0	2548.6	2549.1	1906.2	.854	1906.2	2	46910		
8	6274	6274	0	0	0	0	0.0	3214.1	3214.1	2571.2	.885	665.0	2	46910		
8	6305	6305	0	0	0	0	0.0	3954.5	3954.5	3311.6	.908	1405.4	2	46910		
3	6322	6322	1	9	0	0	4367.3	4367.3	4368.1	3724.4	.918	1818.2	2	46910		
8	6335	6335	0	0	0	0	0.0	4674.3	4674.3	4030.6	.923	306.2	2	46910		
8	7002	7002	0	0	0	0	0.0	5447.0	5447.0	4803.3	.935	1078.9	2	46910		
4	7071	7071	0	0	0	0	0.0	6781.9	6781.9	6138.2	.904	2413.8	2	46910		
0	6153	0	0	0	0	0	298.7	0.0	0.0	0.0	0.000	0.0	2	50580	PLUNGER	SSN 595
3	6241	6241	1	9	0	0	0.0	410.9	410.9	112.2	.053	112.2	2	50580		
4	7032	7032	0	0	0	0	0.0	503.7	503.7	205.0	.035	92.8	2	50580		
0	6112	6112	0	0	0	0	165.5	0.0	0.0	0.0	0.000	0.0	2	51100	ABRAHAM LINCOL	SSBN602
4	7057	7057	0	0	0	0	0.0	643.0	643.0	477.5	.064	477.5	2	51100		
0	6150	0	0	0	0	0	166.0	0.0	0.0	0.0	0.000	0.0	2	51160	ETHAN ALLEN	SSBN608
8	6357	6357	0	0	0	0	0.0	898.5	898.5	732.5	.147	732.5	2	51160		
4	7069	7069	0	0	0	0	0.0	1824.0	1824.0	1658.0	.243	1658.0	2	51160		
NO INITIAL RECORD-FIRST RECORD USED																
3	6349	6349	1	14	0	0	1348.5	1348.5	1348.5	0.0	0.000	0.0	2	51170	SAM HOUSTON	SSBN609
4	7057	7057	0	0	0	0	0.0	1534.0	1534.0	185.5	.106	185.5	2	51170		
NO INITIAL RECORD-FIRST RECORD USED																
3	6171	6173	1	14	0	0	199.8	199.6	199.8	0.0	0.000	0.0	2	51480	HAWKBILL	SSN 666
3	6181	6181	1	999	0	0	281.0	281.3	282.7	81.5	.340	81.5	2	51480		
3	6181	6181	1	1	0	0	290.0	290.0	291.5	88.8	.370	7.3	2	51480		
8	6258	6258	0	0	0	0	0.0	1023.5	1023.5	820.8	.393	732.0	2	51480		
3	6286	6286	1	14	0	0	0.0	1192.1	1193.1	989.4	.358	900.6	2	51480		

FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		RA	DL1	DL2	DL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
3	6322	6322	1	5	0	0	1478.6	1477.6	1478.6	1273.9	.352	284.5	2	51480		
4	7053	7053	0	0	0	0	0.0	2256.0	2256.0	2051.3	.346	777.4	2	51480		
0	6153	0	0	0	0	0	137.0	0.0	0.0	0.0	0.000	0.0	2	58490	WICHITA	AOR 1
8	6198	6198	0	0	0	0	0.0	331.0	331.0	194.0	.180	194.0	2	58490		
8	6218	621[illegible]	0	0	0	0	0.0	505.3	505.3	368.3	.236	368.3	2	58490		
3	6236	6245	1	23	0	0	1134.0	930.0	1134.0	793.0	.359	793.0	2	58490		
3	6256	6256	1	4	0	0	0.0	1158.0	1158.0	817.0	.331	24.0	2	58490		
0	6256	6256	0	0	0	0	112.3	0.0	0.0	0.0	0.000	0.0	2	58490	WICHITA	AOR 1
4	7041	7041	0	0	0	0	0.0	2990.6	2990.6	2878.3	.800	2878.3	2	58490		
0	6154	0	0	0	0	0	1198.0	0.0	0.0	0.0	0.000	0.0	2	200280	SAN BERNARDINO	LST1189
3	6202	6211	1	9	18	0	2174.0	1938.8	2174.0	740.8	.542	740.8	2	200280		
8	6217	6219	0	0	0	0	0.0	2307.0	2307.0	873.8	.560	133.0	2	200280		
8	6257	6257	0	0	0	0	0.0	3172.9	3172.9	1739.7	.704	998.9	2	200280		
3	6365	6365	1	5	0	0	0.0	5635.8	5635.8	4202.6	.830	3461.8	2	200280		
4	7071	7071	0	0	0	0	0.0	7299.2	7299.2	5866.0	.867	1663.4	2	200280		
0	6182	6182	0	0	0	0	465.0	0.0	0.0	0.0	0.000	0.0	2	201220	KANSAS CITY	AOR 3
3	6195	6195	1	5	4	0	0.0	471.0	471.0	6.0	.019	6.0	2	201220		
0	6195	6195	0	0	0	0	210.0	0.0	0.0	0.0	0.000	0.0	2	201220	KANSAS CITY	AOR 3
3	6269	6269	1	18	0	0	683.5	682.3	683.5	472.3	.266	472.3	2	201220		
8	7040	7040	0	0	0	0	3956.0	3956.0	3956.0	3744.8	.743	3272.5	2	201220		
4	7080	7080	0	0	0	0	0.0	4751.7	4751.7	4540.5	.757	4068.2	2	201220		
0	6153	0	0	0	0	0	254.0	0.0	0.0	0.0	0.000	0.0	2	527040	JOUETT	CG 29
8	6184	6184	0	0	0	0	0.0	269.1	269.1	15.1	.020	15.1	2	527040		
8	6214	6214	0	0	0	0	0.0	726.9	726.9	472.9	.323	472.9	2	527040		
3	6223	6223	1	9	0	0	0.0	836.0	836.0	582.0	.346	582.0	2	527040		
3	6245	6245	1	9	0	0	1389.4	1389.4	1389.4	1135.4	.514	553.4	2	527040		
8	6274	6274	0	0	0	0	0.0	2125.2	2125.2	1871.2	.644	735.8	2	527040		
8	6306	6306	0	0	0	0	0.0	2832.5	2832.5	2578.5	.702	1443.1	2	527040		
0	7033	0	0	0	0	0	3969.3	0.0	0.0	0.0	0.000	0.0	2	527041	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	4090.8	4090.8	121.5	1.013	121.5	2	527041		
0	7033	0	0	0	0	0	834.0	0.0	0.0	0.0	0.000	0.0	2	527042	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	955.5	955.5	121.5	1.013	121.5	2	527042		
0	7033	0	0	0	0	0	936.6	0.0	0.0	0.0	0.000	0.0	2	527043	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	1058.2	1058.2	121.6	1.013	121.6	2	527043		
0	7033	0	0	0	0	0	771.1	0.0	0.0	0.0	0.000	0.0	2	527044	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	892.5	892.5	121.4	1.012	121.4	2	527044		
0	6156	0	0	0	0	0	701.6	0.0	0.0	0.0	0.000	0.0	2	540570	WHIPPLE	FF 1062
3	6260	6261	1	23	15	0	1370.0	1370.0	1380.0	668.4	.265	668.4	2	540570		
3	6345	6345	1	22	0	0	2613.0	2603.0	2613.0	1891.4	.417	1223.0	2	540570		
4	7080	7080	0	0	0	0	0.0	4529.7	4529.7	3808.1	.549	1916.7	2	540570		

R E L I A B I L I T Y

WSC-3 PAC SYSTEM LEVEL

TIME TO FAIL	NO. FAILURES	NO. CENSORED	SURVIVORS	CPDF	EXPONENTIAL	MAX DIFFERENCE
6.0	1.		45.	.022	.003	.019
7.3	1.		44.	.043	.003	.040
24.0	1.		43.	.065	.011	.054
28.9		1.				
74.5	1.		41.	.087	.035	.052
81.5	1.		40.	.110	.038	.072
92.8		1.				
112.2	1.		38.	.133	.052	.080
121.4		1.				
121.5		2.				
121.6		1.				
185.5		1.				
199.7	1.		32.	.159	.091	.068
284.5	1.		31.	.185	.127	.058
334.7	1.		30.	.211	.148	.064
472.3	1.		29.	.238	.202	.036
477.5		1.				
553.4	1.		27.	.265	.232	.032
565.5	1.		26.	.292	.237	.055
582.0	1.		25.	.319	.243	.076
668.4	1.		24.	.347	.274	.073
740.8	1.		23.	.374	.298	.076
777.4		1.				
793.0	1.		21.	.402	.316	.087
829.4	1.		20.	.431	.327	.103
890.0	1.		19.	.459	.347	.113
900.6	1.		18.	.488	.350	.138
913.3	1.		17.	.516	.354	.162
1223.0	1.		16.	.545	.443	.102
1314.6	1.		15.	.573	.467	.106
1443.1		1.				
1658.0		1.				
1663.4		1.				
1818.2	1.		11.	.609	.581	.028
1906.2	1.		10.	.644	.598	.046
1916.7		1.				
2413.8		1.				
2878.3		1.				
3461.8	1.		6.	.695	.809	.165
3580.4		1.				
3795.7	1.		4.	.756	.837	.142
4068.2		1.				
4220.1		1.				
5942.1		1.				

R E L I A B I L I T Y

WSC-3 PAC SYSTEM LEVEL

EQUIPMENT OPERATING HOURS (O.H.) = 54384.8   CALENDAR HOURS(C.H.) =, 92616.0   DUTY CYCLE (O.H./C.H.) = .587

NUMBER OF FAILURES = 26.   OBSERVED FAILURE RATE/O.H. = .47807E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE (.10,26.) = .188

MAX DIFF CALC = .165, IS LESS THAN CRITICAL VALUE THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 2091.723,   EST. MEDIAN = 1449.872,   90 PER CENT LCL FOR MEAN = 1607.6,   90 PER CENT UCL FOR MEAN = 2757.664

90 PERCENT UCL   2757.66 IS LESS THAN   3000.00 HOURS, THUS A RELIABILITY PROBLEM EXISTS

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RELIABILITY

WSC-3 PAC   O-LEVEL SUMMARY

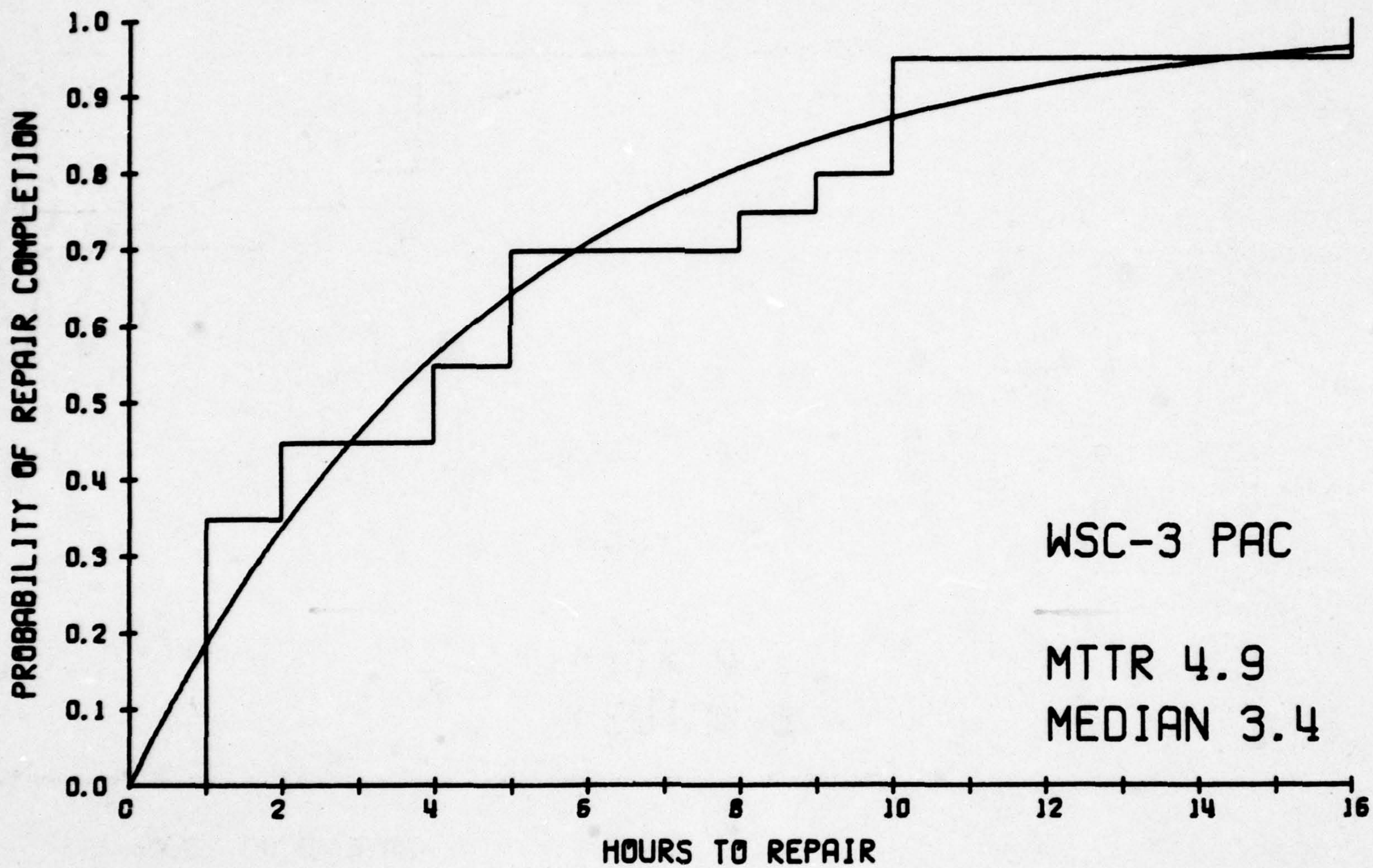
WRA	O-LEVEL BLOCK NO.	O-LEVEL NOMENCLATURE	NUMBER FAILURES	LOWER 90 CONF LIM	MEAN	UPPER 90 CONF LIM	SPEC MTBF	OBSERVED FAILURE TIMES LOW	OBSERVED FAILURE TIMES HIGH	RELIAB PROBLEM
1	1		3.	8140,46	18128,27	49348,09	22188,00	88,80	1314,60	NO
1	4		3.	8140,46	18128,27	49348,09	1000000,00	6,00	817,00	YES
1	5		4.	6803,59	13596,20	31170,18	31025,00	6,00	4202,60	NO
1	6		1.	13981,67	54384,80	516180,71	92843,00	829,40	829,40	NO
1	9		6.	5163,72	9064,13	17254,61	15533,00	112,20	3724,40	NO
1	14		1.	13981,67	54384,80	516180,71	64726,00	989,40	989,40	NO
1	15		1.	13981,67	54384,80	516180,71	37023,00	668,40	668,40	NO
1	18		3.	8140,46	18128,27	49348,09	30056,00	472,30	1906,20	NO
1	22		2.	10218,29	27192,40	102263,30	96414,00	1099,90	1891,40	NO
1	23		4.	6803,59	13596,20	31170,18	72711,00	668,40	1989,90	YES
1	999		2.	10218,29	27192,40	102263,30	2000000,00	81,50	5184,80	YES

R E L I A B I L I T Y

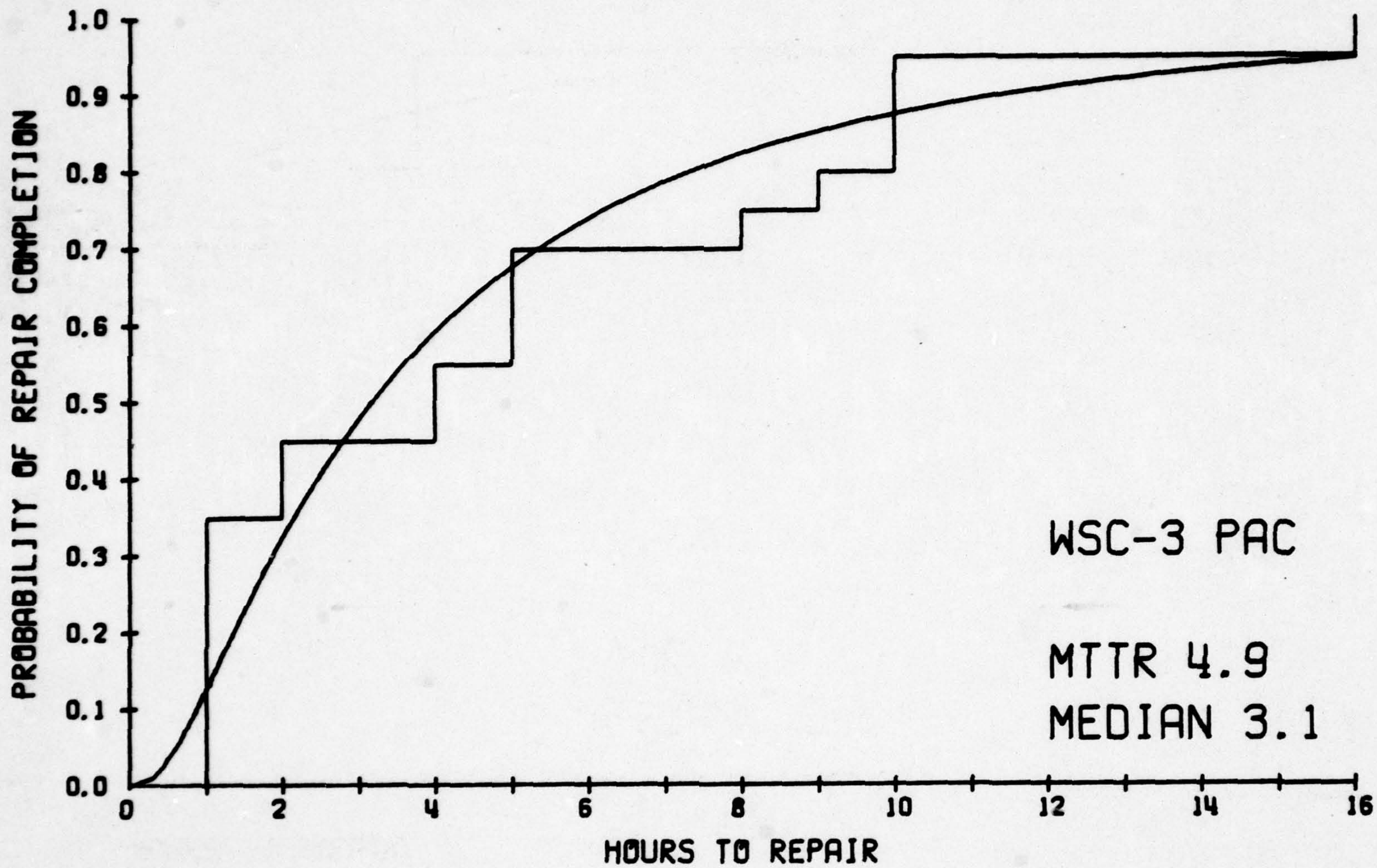
2K SUMMARY FOR WSC-3 PAC PROBLEM AREAS

JCN	SYSTEM	WRA	D-L	D-L	D-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
03135DE01	2	1	23	0	0	PSK INOP	VISUAL	RPL LOGIC MOD A5
04663DE020096	2	1	999	0	0	NO XMIT KEY		R R CR22 ? MODULE
04679DE02M061	2	1	4	0	0	NO T/R	ALL BIT	ESHORTED CAP IN A23
04679DE02M085	2	1	23	0	0	NO XMT PSK	NONE	RPL XMT LOGIC MOD
05148DC010287	2	1	999	0	0	NO RCV AM	NONE	REP BROKEN WIRE
05849DE01	2	1	23	0	0	BAD STRAP	NONE	CHANGED STRAPPING
05849	2	1	4	0	0			RPL WSC-3"REP 5MHZ
20122	2	1	5	4	0	DOWN REPLAC	D	RPL SYNTH /FREQ ST
54057DE011546	2	1	23	15	0	NO PSK	CV PSK	RPL LOGIC, DATA MD

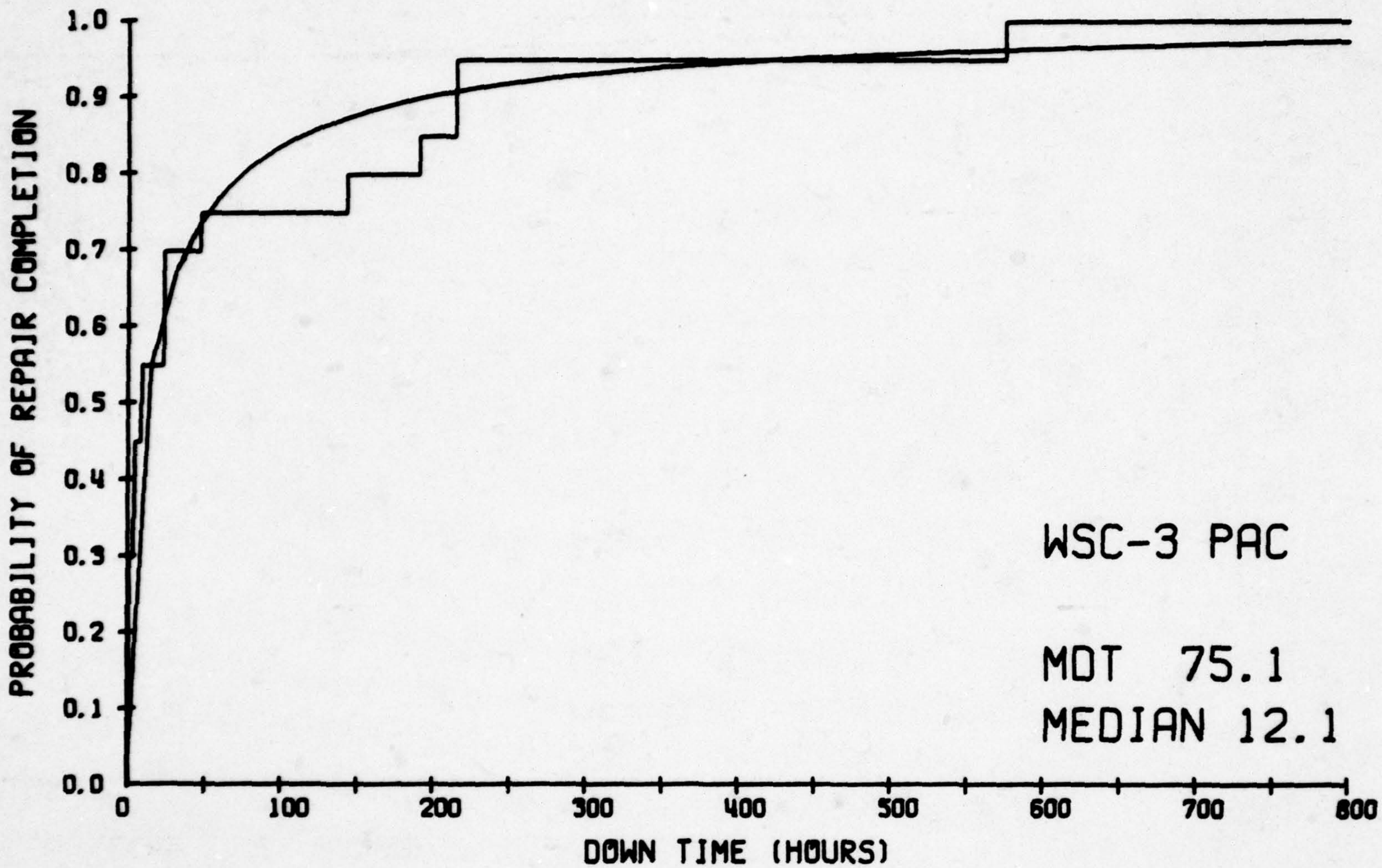
CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL LOGNORMAL PROBABILITY DISTRIBUTION FOR DOWN TIME



FLEET MAINTAINABILITY ASSESSMENT DATA

WRA	OL1	OL2	OL3	DISCOVERY DATE	COMPLETION DATE	DOWN TIME (HRS)	REPAIR TIME (HRS)	SYS	UIC
1	23	0	0	6198	6198	0.0	0.0	2	03135
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	1	0	0	6258	6258	5.0	5.0	2	04663
1	9	0	0	6268	6268	1.0	1.0	2	04663
1	999	0	0	7060	7061	24.0	8.0	2	04663
1	6	0	0	6194	6195	24.0	10.0	2	04664
1	4	0	0	6169	6169	5.0	5.0	2	04679
1	5	0	0	6177	6183	144.0	1.0	2	04679
1	22	1	0	6205	6229	576.0	5.0	2	04679
1	23	0	0	6256	6264	192.0	2.0	2	04679
1	18	0	0	6246	6246	0.0	0.0	2	04691
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	9	0	0	6322	6322	0.0	0.0	2	04691
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	9	0	0	6241	6241	0.0	0.0	2	05058
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	14	0	0	6349	6349	1.0	1.0	2	05117
1	14	0	0	6171	6173	48.0	2.0	2	05148
1	999	0	0	6181	6181	10.0	10.0	2	05148
1	1	0	0	6181	6181	9.0	9.0	2	05148
1	14	0	0	6286	6286	1.0	1.0	2	05148
1	5	0	0	6322	6322	1.0	1.0	2	05148
1	23	0	0	6236	6245	216.0	4.0	2	05849
1	4	0	0	6256	6256	0.0	0.0	2	05849
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	9	18	0	6202	6211	216.0	16.0	2	20028
1	5	0	0	6365	6365	0.0	0.0	2	20028
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	5	4	0	6195	6195	0.0	0.0	2	20122
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	18	0	0	6269	6269	4.0	4.0	2	20122
1	9	0	0	6223	6223	1.0	1.0	2	52704
1	9	0	0	6245	6245	0.0	0.0	2	52704
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	23	15	0	6260	6261	24.0	10.0	2	54057
1	22	0	0	6345	6345	1.0	1.0	2	54057

MAINTAINABILITY (REPAIR TIME)

WSC-3 PAC   SYSTEM LEVEL

REPAIR TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	7.	7.0	.333	.126	.208
2.0	2.	9.0	.429	.325	.104
4.0	2.	11.0	.524	.594	.166
5.0	3.	14.0	.667	.678	.154
8.0	1.	15.0	.714	.824	.158
9.0	1.	16.0	.762	.853	.139
10.0	3.	19.0	.905	.876	.114
16.0	1.	20.0	.952	.948	.043

TOTAL REPAIR HOURS = 97.0   NUMBER OF REPAIRS = 20.   OBSERVED REPAIR RATE/HR = .2062E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 1.15   STD DEV OF LN'S = 1.00

K-S CRITICAL VALUE (.10, 20.) = .174   MAX DIFF CALC = .208 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

REPAIR TIME	FREQUENCY	CUM FREQUENCY	NPF	EXPONENTIAL	MAX DIFFERENCE
1.0	7.	7.	.333	.186	.147
2.0	2.	9.	.429	.338	.091
4.0	2.	11.	.524	.562	.133
5.0	3.	14.	.667	.643	.120
8.0	1.	15.	.714	.808	.141
9.0	1.	16.	.762	.844	.129
10.0	3.	19.	.905	.873	.111
16.0	1.	20.	.952	.963	.058

TOTAL REPAIR HOURS = 97.0   NUMBER OF REPAIRS = 20.   OBSERVED REPAIR RATE/HR = .2062E+00

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE (.10, 20.) = .212   MAX DIFF CALC = .147 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

EST MEAN = 4.85   EST MEDIAN = 3.36   90 PER CENT LCL ON MEAN = 3.74   90 PER CENT UCL ON MEAN = 6.68

SPECIFIED MTTR = .17 HOURS   LOWER CONF LIM 3.74 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (DOWN TIME)

WSC-3 PAC   SYSTEM LEVEL

DOWN TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	6.	6.0	.286	.125	.161
4.0	1.	7.0	.333	.304	.029
5.0	2.	9.0	.429	.342	.087
9.0	1.	10.0	.476	.446	.030
10.0	1.	11.0	.524	.465	.059
24.0	3.	14.0	.667	.624	.101
48.0	1.	15.0	.714	.738	.072
144.0	1.	16.0	.762	.874	.160
192.0	1.	17.0	.810	.900	.138
216.0	2.	19.0	.905	.909	.099
576.0	1.	20.0	.952	.963	.058

TOTAL DOWN TIME (TDT) = 1503.0   NUMBER OF REPAIRS (NR) = 20.   OBSERVED DOWN TIME/REPAIR (TDT/NR) = 75.15

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 2.49   STD DEV OF LN'S = 2.16

K-S CRITICAL VALUE (.10, 20.) = .174   MAX DIFF CALC = .161 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 75.15   EST MEDIAN = 12.09   90 PER CENT LCL ON MEDIAN = 6.36   90 PER CENT UCL ON MEDIAN = 22.97

MAINTAINABILITY (REPAIR TIME)

WSC-3 PAC O-LEVEL SUMMARY

WRA	O-LEVEL BLOCK NO.	O-LEVEL NOMENCLATURE	NUMBER REPAIRS	LOWER 90 CONF LIM	UPPER 90 CONF LIM	SPEC MTTR	OBSERVED REPAIR TIMES LOW	MEAN	HIGH	MAINT PROBLEM
1	1 A1A2	POWER SUPPLY VOLTAG REGULATOR	3.	4.20	8.80	.2	5.0	6.33	9.0	YES
1	4 A1A23	FREQUENCY STANDARD	1.	NO CONF LIMITS		.2	5.0	5.00	5.0	
1	5 A1A8	SYNTHESIZER	2.	NO CONF LIMITS		.2	1.0	1.00	1.0	
1	6 A1A9	CONTROL CONVERTER	1.	NO CONF LIMITS		.2	10.0	10.00	10.0	
1	9 A1A1	EXCITER / PA	3.	.44	14.40	.2	1.0	6.00	16.0	YES
1	14 A1A15	A M DETECTOR	3.	.81	1.95	.2	1.0	1.33	2.0	YES
1	15 A1A10	FM/PSK/FSK MODULATOR	1.	NO CONF LIMITS		.2	10.0	10.00	10.0	
1	18 A1A7	PSK DETECTOR	2.	.95	67.56	.2	4.0	10.00	16.0	YES
1	22 A1A3	PSK RECEIVE LOGIC	2.	.19	26.62	.2	1.0	3.00	5.0	YES
1	23 A1A5	PSK TRANSMIT LOGIC	3.	1.79	10.38	.2	2.0	5.33	10.0	YES
1	999		2.	6.34	12.61	.2	8.0	9.00	10.0	YES

MAINTAINABILITY (REPAIR TIME)

2K SUMMARY FOR WSC-3 PAC PROBLEM AREAS

JCN	SYSTEM	WRA	O-L	O-L	O-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
03135□E01	2	1	23	0	0	PSK INOP	VISUAL	RPL LOGIC MOD A5
04663□E02M114	2	1	1	0	0	NO OUTPUT	VISUAL	RPL V,REG DIODES
04663□E02M114	2	1	9	0	0	NO AUDIO	NONE	REPLACED XMTR
04663□E020096	2	1	999	0	0	NO XMIT KEY		R R CR22 ? MODULE
04664□E020449	2	1	6	0	0	NOT KEY	VISUAL	RPL CONT CONVERTER
04679□E02M061	2	1	4	0	0	NO T/R	ALL BIT	ESHORTED CAP IN A23
04679□E02M067	2	1	5	0	0	NO RCV AM	BITE	RPL SYNTHESIZER
04679□E02M070	2	1	22	1	0	NO RCV PSK	BITE	RPL VR,PS LOG MOD
04679□E02M085	2	1	23	0	0	NO XMT PSK	NONE	RPL XMT LOGIC MOD
04691□E020500	2	1	18	0	0	NOT RCV PSK	BITE	RPL PSK DETECTOR
04691□E020516	2	1	9	0	0	NO TRANSMIT	BITE 10	REPLACED XMTR
05058□C010388	2	1	9	0	0	NO PWROUT		REPLACED XMTR
05117□C010477	2	1	14	0	0	NO RCV AM		RPL AM DETECTOR
05148□E01	2	1	14	0	0	NO SQUELCH	BITE	RPL RF-AM DET
05148□C010287	2	1	999	0	0	NO RCV AM	NONE	REP BROKEN WIRE
05148□C010286	2	1	1	0	0	NO 28 V	NONE	RPL V, REG
05148□E010836	2	1	14	0	0	NO SQUELCH	BITE	RPL RF-AM DETT
05148□E010857	2	1	5	0	0	NO FUNCT	BITE LI	TREPLACED SYNT
05849□E01	2	1	23	0	0	BAD STRAP	NONE	CHANGED STRAPPING
05849	2	1	4	0	0			RPL WSC-3"REP 5MHZ
20028□E010872	2	1	9	18	0	NO RCV SAT	BITE	RPL XTRDO + PSK DT
20028	2	1	5	0	0			RPL SYNTHESIZER
20122	2	1	5	4	0	DOWN REPLAC	D	RPL SYNTH /FREQ ST
20122□E01	2	1	18	0	0	NO RCV PSK	NONE	RPL PSK DET
52704wP010800	2	1	9	0	0	NO PWR		BUSTED A1A1A10R2
52704wP01	2	1	9	0	0	XMTR BROKE	IVISUAL	RPL XMTR
54057□E011546	2	1	23	15	0	NO PSK	CV PSK	RPL LOGIC, DATA MD
54057□E011560	2	1	22	0	0	NONE	BITE 21	RPL PHASE SHFTLOG

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RMA SUMMARY WSC-3 PAC   SYSTEM LEVEL

TTF DISTRIBUTION IS EXPONENTIAL WITH MEAN =   2091.72

DT DISTRIBUTION IS LOGNORMAL WITH MEAN OF LNS =   2.49000 AND STANDARD [illegible]

RT DISTRIBUTION IS EXPONENTIAL WITH MEAN =   4.85

INHERENT AVAILABILITY = MTBF/(MTBF+MTTR)

MEAN TIME TO FAILURE =   2091.72

MEAN REPAIR TIME   =   4.85

INHERENT AVAILABILITY =   .9977

OBSERVED AVAILABILITY (SIMULATION OF RATIOS TTF/(TTF+DT))

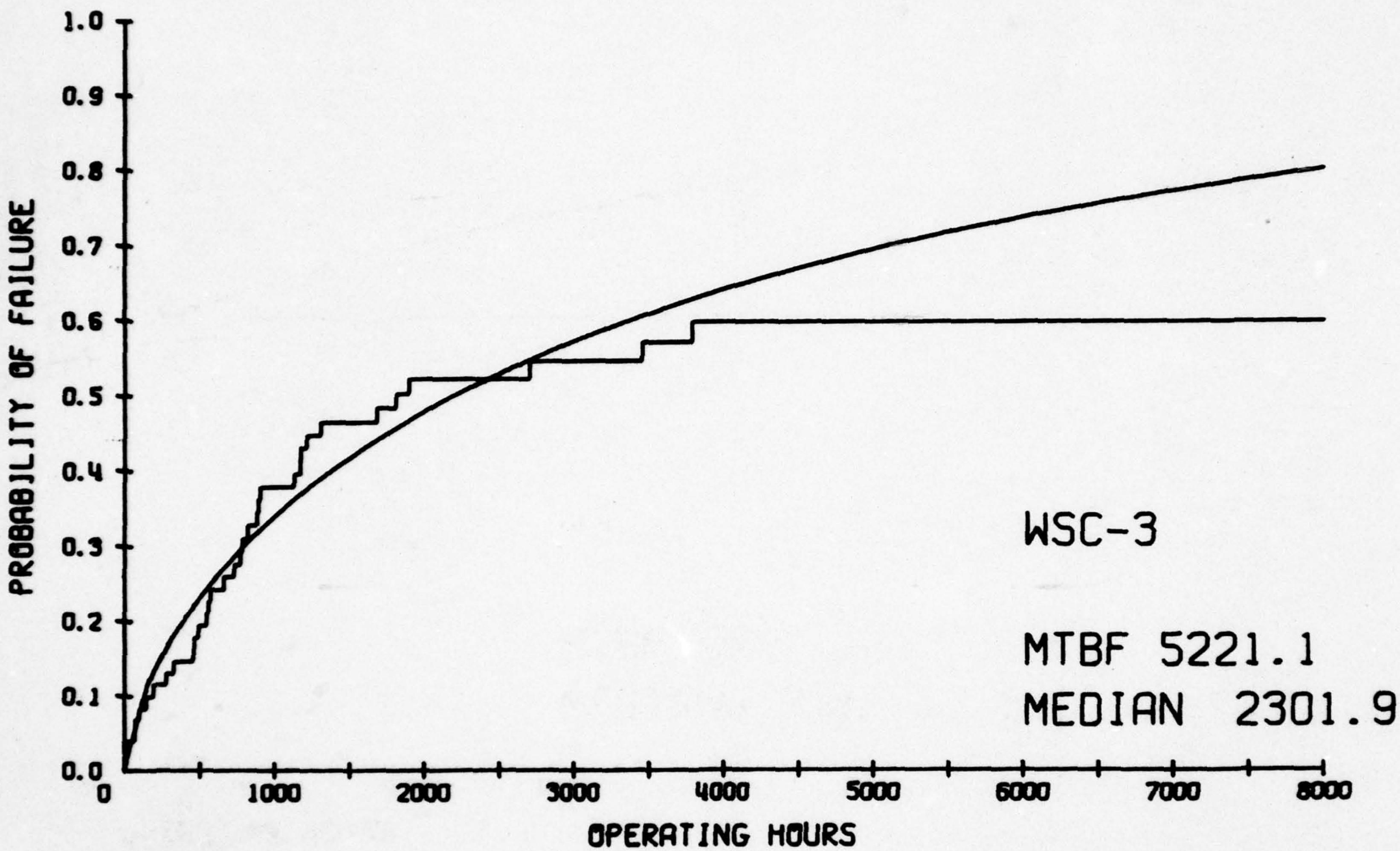
90 PERCENT LCL ON INDIVIDUALS =   .8183

90 PERCENT UCL ON INDIVIDUALS =   .9968

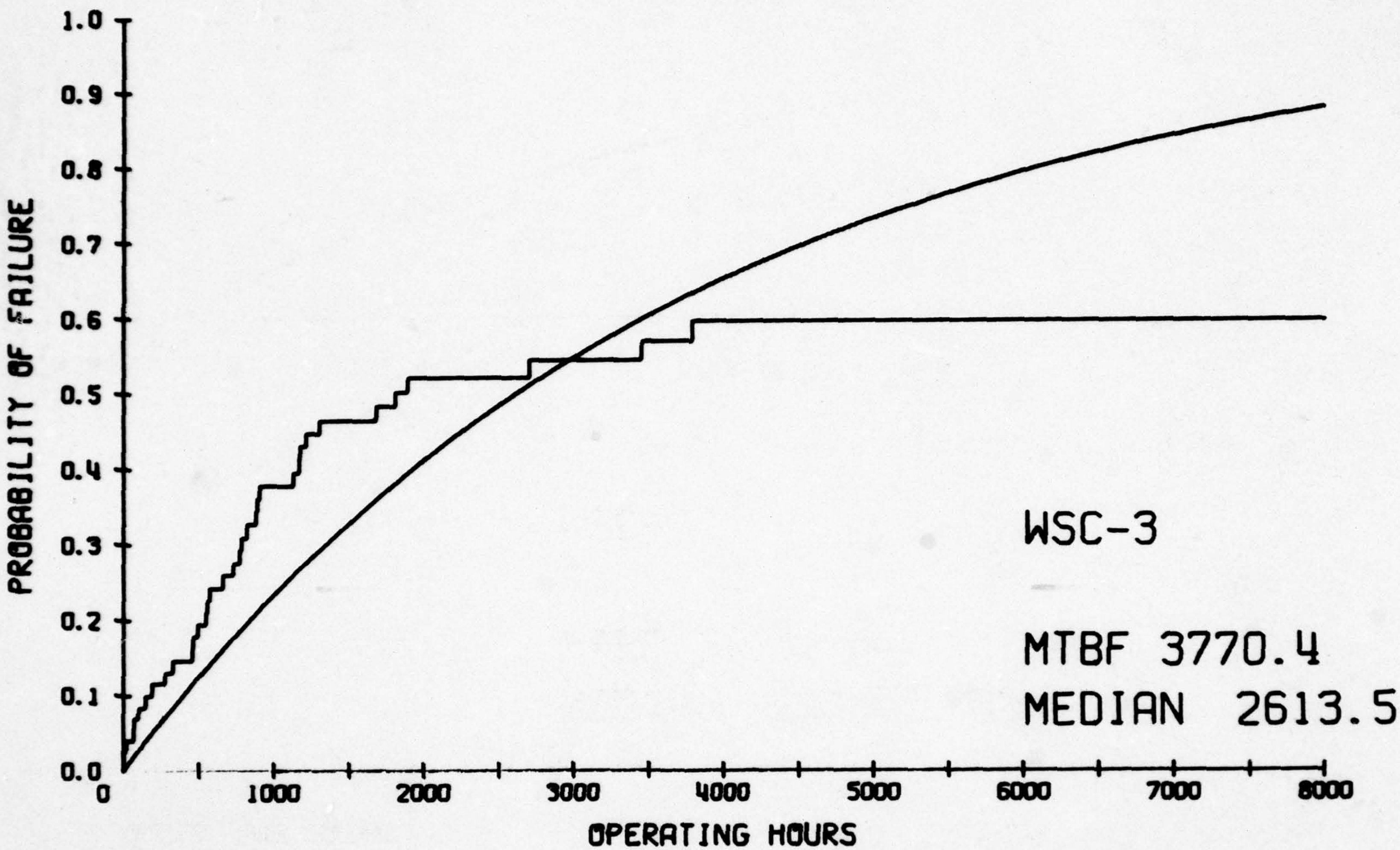
MEAN   =   .9355

MEDIAN   =   .9840

CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL WEIBULL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO FAILURE



FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		RA	DL1	DL2	DL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
0	6153	0	0	0	0	0	1412.2	0.0	0.0	0.0	0.000	0.0	2	31350	MONTICELLO	LSD 35
3	6198	6198	1	23	0	0	0.0	2325.5	2325.5	913.3	.846	913.3	2	31350		
4	7072	7072	0	0	0	0	0.0	5905.9	5905.9	4493.7	.659	3580.4	2	31350		
0	6181	0	0	0	0	0	1365.1	0.0	0.0	0.0	0.000	0.0	2	33681	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	6884.0	6884.0	5518.9	.970	5518.9	2	33681		
4	7090	7090	0	0	0	0	0.0	7748.5	7748.5	6383.4	.971	6383.4	2	33681		
0	6181	0	0	0	0	0	2345.0	0.0	0.0	0.0	0.000	0.0	2	33682	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	7863.0	7863.0	5518.0	.970	5518.0	2	33682		
4	7090	7090	0	0	0	0	0.0	8725.8	8725.8	6380.8	.970	6380.8	2	33682		
0	6181	0	0	0	0	0	499.0	0.0	0.0	0.0	0.000	0.0	2	33683	NIMITZ	CV 68
8	7053	7053	0	0	0	0	0.0	6019.0	6019.0	5520.0	.970	5520.0	2	33683		
4	7090	7090	0	0	0	0	0.0	6881.1	6881.1	6382.1	.971	6382.1	2	33683		
0	6181	0	0	0	0	0	364.5	0.0	0.0	0.0	0.000	0.0	2	33684	NIMITZ	CV 68
3	6252	6252	1	22	0	0	0.0	2052.0	2052.0	1687.5	.990	1687.5	2	33684		
6	6354	6354	1	12	0	0	0.0	4759.6	4759.6	4395.1	1.059	2707.6	2	33684		
8	7053	7053	0	0	0	0	0.0	5252.0	5252.0	4887.5	.859	492.4	2	33684		
4	7090	7090	0	0	0	0	0.0	5420.6	5420.6	5056.1	.769	661.0	2	33684		
0	6155	0	0	0	0	0	551.3	0.0	0.0	0.0	0.000	0.0	2	46630	SOMERS	DDG 34
3	6258	6258	1	1	0	0	1870.9	1865.9	1870.9	1314.6	.532	1314.6	2	46630		
3	6268	6268	1	9	0	0	1745.4	1945.4	1946.6	1389.1	.512	74.5	2	46630		
3	7060	7061	1	999	0	0	0.0	5742.3	5742.3	5184.8	.797	3795.7	2	46630		
4	7084	7084	0	0	0	0	0.0	5771.2	5771.2	5213.7	.739	28.9	2	46630		
0	6155	0	0	0	0	0	2122.0	0.0	0.0	0.0	0.000	0.0	2	46640	MORTON	DD 948
3	6194	6195	1	6	0	0	2951.0	2951.4	2961.5	829.4	.864	829.4	2	46640		
8	6258	6258	0	0	0	0	0.0	4266.8	4266.8	2134.7	.864	1305.3	2	46640		
4	7087	7087	0	0	0	0	0.0	8903.6	8903.6	6771.5	.950	5942.1	2	46640		
0	6159	0	0	0	0	0	2302.9	0.0	0.0	0.0	0.000	0.0	2	46680	ADAMS,CHARLES	DDG 2
3	6209	6211	1	5	0	0	3087.2	3084.9	3087.2	782.0	.627	782.0	2	46680		
4	7084	7084	0	0	0	0	0.0	8438.5	8438.5	6133.3	.881	5351.3	2	46680		
0	6153	0	0	0	0	0	1340.0	0.0	0.0	0.0	0.000	0.0	2	46790	HOEL	DDG 13
6	6169	6169	1	4	0	0	0.0	1674.7	1674.7	334.7	.872	334.7	2	46790		
3	6177	6183	1	5	0	0	0.0	1874.4	1874.5	534.4	.742	199.7	2	46790		
3	6205	6229	1	22	1	0	0.0	2440.0	2513.0	1099.9	.603	565.5	2	46790		
3	6256	6264	1	23	0	0	0.0	3403.0	3404.0	1989.9	.747	890.0	2	46790		
8	6274	6274	0	0	0	0	0.0	3793.3	3793.3	2379.2	.819	389.3	2	46790		
8	6293	6293	0	0	0	0	0.0	4227.0	4227.0	2812.9	.837	823.0	2	46790		
8	6315	6315	0	0	0	0	0.0	4756.1	4756.1	3342.0	.860	1352.1	2	46790		
8	6344	6344	0	0	0	0	0.0	5466.5	5466.5	4052.4	.884	2062.5	2	46790		
8	6355	6355	0	0	0	0	0.0	5730.7	5730.7	4316.6	.890	2326.7	2	46790		
8	7040	7040	0	0	0	0	0.0	6930.9	6930.9	5516.8	.912	3526.9	2	46790		
4	7071	7071	0	0	0	0	0.0	7624.1	7624.1	6210.0	.914	4220.1	2	46790		
0	6153	0	0	0	0	0	642.4	0.0	0.0	0.0	0.000	0.0	2	46910	WADDELL	DDG 24
3	6246	6246	1	18	0	0	0.0	2548.6	2549.1	1906.2	.854	1906.2	2	46910		
8	6274	6274	0	0	0	0	0.0	3214.1	3214.1	2571.2	.885	665.0	2	46910		
8	6305	6305	0	0	0	0	0.0	3954.5	3954.5	3311.6	.908	1405.4	2	46910		
3	6322	6322	1	9	0	0	4367.3	4367.3	4368.1	3724.4	.918	1818.2	2	46910		
8	6335	6335	0	0	0	0	0.0	4674.3	4674.3	4030.6	.923	306.2	2	46910		
8	7002	7002	0	0	0	0	0.0	5447.0	5447.0	4803.3	.935	1078.9	2	46910		
4	7071	7071	0	0	0	0	0.0	6781.9	6781.9	6138.2	.904	2413.8	2	46910		

FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		#RA	DL1	DL2	DL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
0	6154	0	0	0	0	0	2403.1	0.0	0.0	0.0	0.000	0.0	2	46980	PAGE,RICHARD L	FFG 5
3	6194	6196	1	9	0	0	0.0	3544.1	3544.1	1141.0	1.132	1141.0	2	46980		
8	7098	7098	0	0	0	0	0.0	9576.0	9576.0	7172.9	.967	6031.9	2	46980		
4	7115	7115	0	0	0	0	0.0	9989.4	9989.4	7585.3	.970	6445.3	2	46980		
0	6155	0	0	0	0	0	1219.1	0.0	0.0	0.0	0.000	0.0	2	46990	FURER,JULIUS A	FFG 6
3	6162	6188	1	18	0	0	1720.0	1720.0	1729.0	500.9	.632	500.9	2	46990		
8	6265	6265	0	0	0	0	0.0	3031.8	3081.8	1853.7	.702	1352.9	2	46990		
4	7082	7082	0	0	0	0	0.0	7231.1	7231.1	6003.0	.857	5502.1	2	46990		
0	6153	0	0	0	0	0	298.7	0.0	0.0	0.0	0.000	0.0	2	50580	PLUNGER	SSN 595
3	6241	6241	1	9	0	0	0.0	410.9	410.9	112.2	.053	112.2	2	50580		
4	7032	7032	0	0	0	0	0.0	503.7	503.7	205.0	.035	92.8	2	50580		
0	6112	6112	0	0	0	0	165.5	0.0	0.0	0.0	0.000	0.0	2	51100	ABRAHAM LINCOL	SSBN602
4	7057	7057	0	0	0	0	0.0	643.0	643.0	477.5	.064	477.5	2	51100		
0	6150	0	0	0	0	0	166.0	0.0	0.0	0.0	0.000	0.0	2	51160	ETHAN ALLEN	SSBN608
8	6357	6357	0	0	0	0	0.0	898.5	898.5	732.5	.147	732.5	2	51160		
4	7069	7069	0	0	0	0	0.0	1824.0	1824.0	1658.0	.243	1658.0	2	51160		
NO INITIAL RECORD-FIRST RECORD USED																
3	6349	6349	1	14	0	0	1348.5	1348.5	1348.5	0.0	0.000	0.0	2	51170	SAM HOUSTON	SSBN609
4	7057	7057	0	0	0	0	0.0	1534.0	1534.0	185.5	.106	185.5	2	51170		
0	6159	0	0	0	0	0	531.5	0.0	0.0	0.0	0.000	0.0	2	51450	SEA DEVIL	SSN 664
4	7087	7087	0	0	0	0	0.0	2797.1	2797.1	2265.6	.322	2265.6	2	51450		
NO INITIAL RECORD-FIRST RECORD USED																
4	7116	7116	0	0	0	0	4779.6	4779.6	4779.6	0.0	0.000	0.0	2	51460	NARWHAL	SSN 671
NO INITIAL RECORD-FIRST RECORD USED																
3	6171	6173	1	14	0	0	199.8	199.6	199.8	0.0	0.000	0.0	2	51480	HAWKBILL	SSN 666
3	6181	6181	1	999	0	0	281.0	281.3	282.7	81.5	.340	81.5	2	51480		
3	6181	6181	1	1	0	0	290.0	290.0	291.5	88.8	.370	7.3	2	51480		
8	6258	6258	0	0	0	0	0.0	1023.5	1023.5	820.8	.393	732.0	2	51480		
3	6286	6286	1	14	0	0	0.0	1192.1	1193.1	989.4	.358	900.6	2	51480		
3	6322	6322	1	5	0	0	1478.6	1477.6	1478.6	1273.9	.352	284.5	2	51480		
4	7053	7053	0	0	0	0	0.0	2256.0	2256.0	2051.3	.346	777.4	2	51480		
0	6159	0	0	0	0	0	1230.0	0.0	0.0	0.0	0.000	0.0	2	51520	FINBACK	SSN 670
4	7101	7101	0	0	0	0	0.0	5117.4	5117.4	3887.4	.528	3887.4	2	51520		
NO INITIAL RECORD-FIRST RECORD USED																
4	7083	7083	0	0	0	0	3463.1	3463.1	3463.1	0.0	0.000	0.0	2	51540	FLYING FISH	SSN 673
0	6153	0	0	0	0	0	137.0	0.0	0.0	0.0	0.000	0.0	2	58490	WICHITA	AOR 1
8	6198	6198	0	0	0	0	0.0	331.0	331.0	194.0	.180	194.0	2	58490		
8	6218	6218	0	0	0	0	0.0	505.3	505.3	368.3	.236	368.3	2	58490		
3	6236	6245	1	23	0	0	1134.0	930.0	1134.0	793.0	.359	793.0	2	58490		
3	6256	6256	1	4	0	0	0.0	1158.0	1158.0	817.0	.331	24.0	2	58490		
0	6256	6256	0	0	0	0	112.3	0.0	0.0	0.0	0.000	0.0	2	58490	WICHITA	AOR 1
4	7041	7041	0	0	0	0	0.0	2990.6	2990.6	2878.3	.800	2878.3	2	58490		
0	6155	0	0	0	0	0	1102.2	0.0	0.0	0.0	0.000	0.0	2	58500	MILWAUKEE	AOR 2
6	6196	6226	1	999	0	0	0.0	1258.0	1258.0	155.8	.091	155.8	2	58500		
4	7073	7073	0	0	0	0	0.0	5131.0	5131.0	4028.8	.593	3873.0	2	58500		
0	6155	0	0	0	0	0	1040.1	0.0	0.0	0.0	0.000	0.0	2	71940	CORONADO	LPD 11
4	7081	7081	0	0	0	0	0.0	5981.4	5981.4	4941.3	.708	4941.3	2	71940		
NO INITIAL RECORD-FIRST RECORD USED																
4	7081	7081	0	0	0	0	9954.3	9954.3	9954.3	0.0	0.000	0.0	2	73520	GUADALCANAL	LPH 7
0	6155	0	0	0	0	0	601.4	0.0	0.0	0.0	0.000	0.0	2	200190	MANITOWOC	LST1180
3	6229	6231	1	5	0	0	1068.0	1068.0	1068.0	466.6	.256	466.6	2	200190		
8	7049	7049	0	0	0	0	0.0	3170.0	3170.0	2569.6	.413	2102.0	2	200190		
4	7073	7073	0	0	0	0	0.0	3477.6	3477.6	2876.2	.423	2409.6	2	200190		

FLEET RELIABILITY ASSESSMENT DATA

MTYP	DATE		FRA	OL1	OL2	OL3	ETM	ETM1	ETM2	OPERATE	DUTY	TTF	SYS	UIC	SHIP NAME	HULL NO
0	6154	0	0	0	0	0	1198.0	0.0	0.0	0.0	0.000	0.0	2	200280	SAN BERNARDINO	LST1189
3	6202	6211	1	9	18	0	2174.0	1938.0	2174.0	740.8	.542	740.8	2	200280		
8	6217	6219	0	0	0	0	0.0	2307.0	2307.0	873.8	.560	133.0	2	200280		
8	6257	6257	0	0	0	0	0.0	3172.9	3172.9	1739.7	.704	998.9	2	200280		
3	6365	6365	1	5	0	0	0.0	5635.8	5635.8	4202.6	.830	3461.8	2	200280		
4	7071	7071	0	0	0	0	0.0	7299.2	7299.2	5866.0	.867	1663.4	2	200280		
0	6159	0	0	0	0	0	1309.1	0.0	0.0	0.0	0.000	0.0	2	200440	BATFISH	SSN 681
3	6253	6253	1	18	0	0	0.0	2490.0	2490.0	1180.9	.523	1180.9	2	200440		
4	7081	7081	0	0	0	0	0.0	3261.8	3261.8	1952.7	.283	771.8	2	200440		
0	6182	6182	0	0	0	0	465.0	0.0	0.0	0.0	0.000	0.0	2	201220	KANSAS CITY	AOR 3
3	6195	6195	1	5	4	0	0.0	471.0	471.0	6.0	.019	6.0	2	201220		
0	6195	6195	0	0	0	0	210.0	0.0	0.0	0.0	0.000	0.0	2	201220	KANSAS CITY	AOR 3
3	6269	6269	1	18	0	0	683.5	682.3	683.5	472.3	.266	472.3	2	201220		
8	7040	7040	0	0	0	0	3956.0	3956.0	3956.0	3744.8	.743	3272.5	2	201220		
4	7080	7080	0	0	0	0	0.0	4751.7	4751.7	4540.5	.757	4068.2	2	201220		
0	6159	0	0	0	0	0	1104.1	0.0	0.0	0.0	0.000	0.0	2	521970	DAVIS	DD 937
8	6184	6184	0	0	0	0	0.0	1697.2	1697.2	593.1	.989	593.1	2	521970		
3	6209	6210	1	999	0	0	2290.6	2290.6	2293.0	1186.5	.969	1186.5	2	521970		
4	7082	7082	0	0	0	0	0.0	6777.8	6777.8	5671.3	.821	4484.8	2	521970		
0	6159	0	0	0	0	0	5337.0	0.0	0.0	0.0	0.000	0.0	2	521980	INGRAM, JONAS	DD 938
4	7119	7119	0	0	0	0	0.0	7609.0	7609.0	2272.0	.291	2272.0	2	521980		
0	6155	0	0	0	0	0	2606.1	0.0	0.0	0.0	0.000	0.0	2	522000	DUPONT	DD 941
4	7031	7031	0	0	0	0	0.0	8366.3	8366.3	5760.2	.996	5760.2	2	522000		
0	6153	0	0	0	0	0	254.0	0.0	0.0	0.0	0.000	0.0	2	527040	JOUETT	CG 29
8	6184	6184	0	0	0	0	0.0	269.1	269.1	15.1	.020	15.1	2	527040		
8	6214	6214	0	0	0	0	0.0	726.9	726.9	472.9	.323	472.9	2	527040		
3	6223	6223	1	9	0	0	0.0	836.0	836.0	582.0	.346	582.0	2	527040		
3	6245	6245	1	9	0	0	1389.4	1389.4	1389.4	1135.4	.514	553.4	2	527040		
8	6274	6274	0	0	0	0	0.0	2125.2	2125.2	1871.2	.644	735.8	2	527040		
8	6306	6306	0	0	0	0	0.0	2832.5	2832.5	2578.5	.702	1443.1	2	527040		
0	7033	0	0	0	0	0	3969.3	0.0	0.0	0.0	0.000	0.0	2	527041	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	4090.8	4090.8	121.5	1.013	121.5	2	527041		
0	7033	0	0	0	0	0	834.0	0.0	0.0	0.0	0.000	0.0	2	527042	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	955.5	955.5	121.5	1.013	121.5	2	527042		
0	7033	0	0	0	0	0	936.6	0.0	0.0	0.0	0.000	0.0	2	527043	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	1058.2	1058.2	121.6	1.013	121.6	2	527043		
0	7033	0	0	0	0	0	771.1	0.0	0.0	0.0	0.000	0.0	2	527044	JOUETT	CG 29
4	7038	7038	0	0	0	0	0.0	892.5	892.5	121.4	1.012	121.4	2	527044		
0	6156	0	0	0	0	0	701.6	0.0	0.0	0.0	0.000	0.0	2	540570	WHIPPLE	FF 1062
3	6260	6261	1	23	15	0	1370.0	1370.0	1380.0	668.4	.265	668.4	2	540570		
3	6345	6345	1	22	0	0	2613.0	2603.0	2613.0	1891.4	.417	1223.0	2	540570		
4	7080	7080	0	0	0	0	0.0	4529.7	4529.7	3808.1	.549	1916.7	2	540570		

R E L I A B I L I T Y

WSC-3 SYSTEM LEVEL

TIME TO FAIL	NO. FAILURES	NO. CENSORED	SURVIVORS	CPDF	EXPONENTIAL	MAX DIFFERENCE
6.0	1.		70.	.014	.002	.012
7.3	1.		69.	.028	.002	.026
24.0	1.		68.	.042	.006	.036
28.9		1.				
74.5	1.		66.	.057	.020	.037
81.5	1.		65.	.071	.021	.049
92.8		1.				
112.2	1.		63.	.085	.029	.056
121.4		1.				
121.5		2.				
121.6		1.				
155.8	1.		58.	.101	.040	.060
185.5		1.				
199.7	1.		56.	.117	.052	.065
284.5	1.		55.	.132	.073	.060
334.7	1.		54.	.148	.085	.063
466.6	1.		53.	.164	.116	.048
472.3	1.		52.	.180	.118	.062
477.5		1.				
500.9	1.		50.	.196	.124	.071
553.4	1.		49.	.212	.137	.075
565.5	1.		48.	.228	.139	.089
582.0	1.		47.	.244	.143	.101
661.0		1.				
668.4	1.		45.	.261	.162	.098
740.8	1.		44.	.277	.178	.099
771.8		1.				
777.4		1.				
782.0	1.		41.	.294	.187	.107
793.0	1.		40.	.311	.190	.122
829.4	1.		39.	.329	.197	.131
890.0	1.		38.	.346	.210	.136
900.6	1.		37.	.363	.212	.151
913.3	1.		36.	.380	.215	.165
1141.0	1.		35.	.397	.261	.136
1180.9	1.		34.	.415	.269	.146
1186.5	1.		33.	.432	.270	.162
1223.0	1.		32.	.449	.277	.172
1314.6	1.		31.	.466	.294	.172
1443.1		1.				
1658.0		1.				
1663.4		1.				

R E L I A B I L I T Y

NSC-3 SYSTEM LEVEL

TIME TO FAIL	NO. FAILURES	NO. CENSORED	SURVIVORS	CPDF	EXPONENTIAL	MAX DIFFERENCE
1687.5	1.		27.	.485	.361	.125
1819.2	1.		26.	.504	.383	.122
1906.2	1.		25.	.523	.397	.127
1916.7		1.				
2265.6		1.				
2272.0		1.				
2409.6		1.				
2413.8		1.				
2707.6	1.		19.	.547	.512	.035
2878.3		1.				
3461.8	1.		17.	.572	.601	.053
3580.4		1.				
3795.7	1.		15.	.599	.635	.062
3873.0		1.				
3887.4		1.				
4068.2		1.				
4220.1		1.				
4484.8		1.				
4941.3		1.				
5351.3		1.				
5502.1		1.				
5760.2		1.				
5942.1		1.				
6380.8		1.				
6382.1		1.				
6383.4		1.				
6445.3		1.				

R E L I A B I L I T Y

KSC-3 SYSTEM LEVEL

EQUIPMENT OPERATING HOURS (O.H.) =131965.3 CALENDAR HOURS(C.H.) =, 203064.0 DUTY CYCLE (O.H./C.H.) = .650

NUMBER OF FAILURES = 35. OBSERVED FAILURE RATE/O.H. = .26522E-03

DISTRIBUTION DETERMINATION,

K-S CRITICAL VALUE (.10,35.) = .162

MAX DIFF CALC = .172, IS GREATER THAN CRITICAL VALUE THEREFORE THE WEIBULL DISTRIBUTION IS ASSUMED

THE WEIBULL PARAMETERS ARE ALPHA = .453214E-02 BETA = .653754E+00

FOR THE ASSUMED DISTRIBUTION

EST. MEAN = 5221.061, EST. MEDIAN = 2301.887, 90 PER CENT LCL FOR MEAN = 0.000, 90 PER CENT UCL FOR MEAN = 7048.261

R E L I A B I L I T Y

WSC-3 O-LEVEL SUMMARY

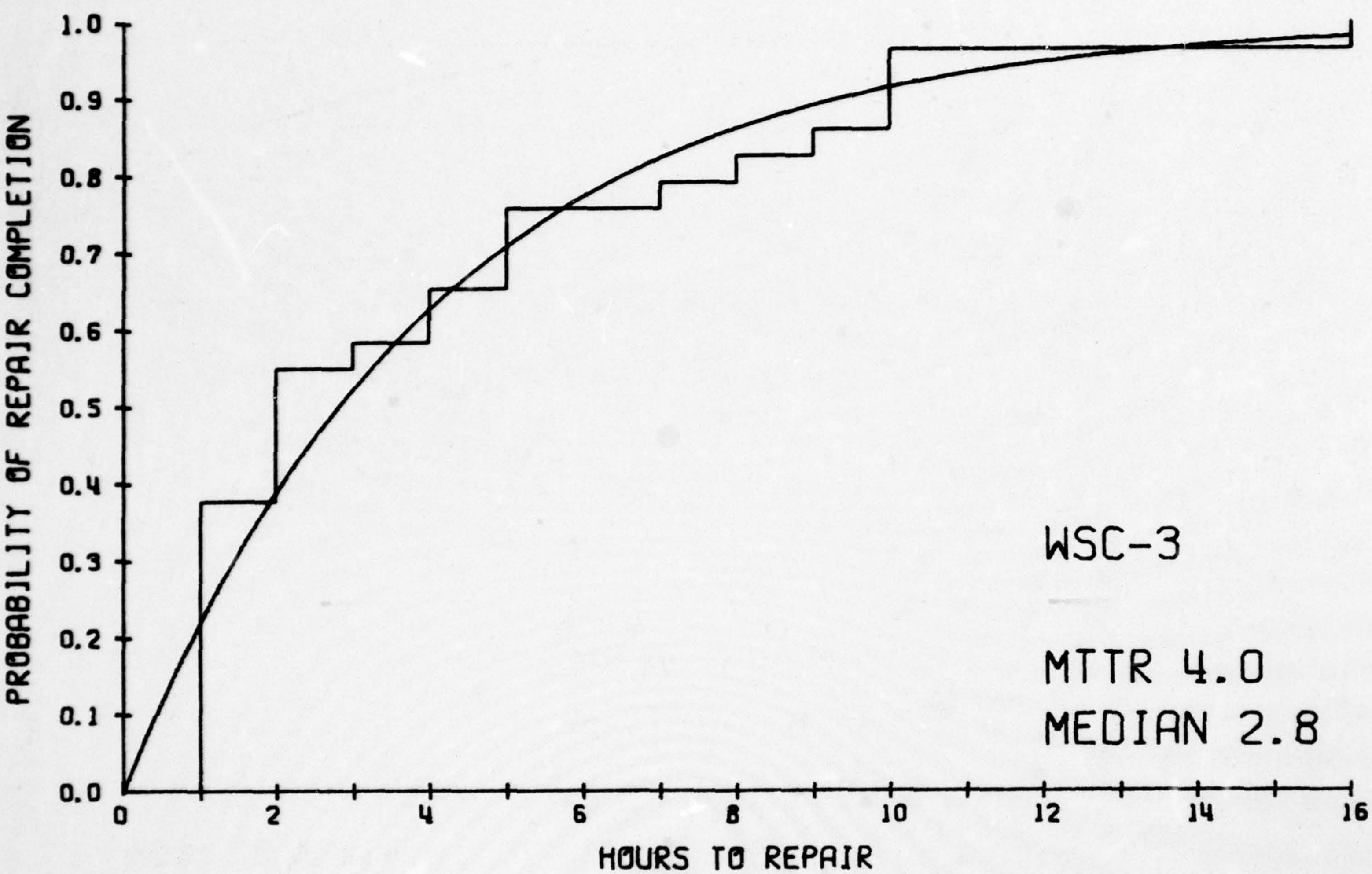
WRA	O-LEVEL BLOCK NO.		O-LEVEL NOMENCLATURE	NUMBER FAILURES	LOWER 90 CONF LIM	MEAN	UPPER 90 CONF LIM	SPEC MTBF	OBSERVED FAILURE TIMES LOW	HIGH	RELIAB PROBLEM
1	1	A1A2	POWER SUPPLY VOLTAG REGULATOR	3.	20551.78	45767.43	124586.39	22188.00	88.80	1314,60	NO
1	4	A1A23	FREQUENCY STANDARD	3.	20551.78	45767.43	124586.39	1000000.00	6.00	817,00	YES
1	5	A1A8	SYNTHESIZER	6.	13036.55	22883.72	43561.76	31025.00	6.00	4202,60	NO
1	6	A1A9	CONTROL CONVERTER	1.	35298.76	137302.30	1303172.93	92843.00	829.40	829,40	NO
1	9	A1A1	EXCITER / PA	7.	11664.55	19614.61	35253.04	15533.00	112.20	3724,40	NO
1	12	A1A22	VOLTAGE CONTROLLED OSCILLATOR	1.	35298.76	137302.30	1303172.93	71608.00	4395.10	4395,10	NO
1	14	A1A15	A M DETECTOR	1.	35298.76	137302.30	1303172.93	64726.00	989.40	989,40	NO
1	15	A1A10	FM/PSK/FSK MODULATOR	1.	35298.76	137302.30	1303172.93	37023.00	668.40	668,40	NO
1	18	A1A7	PSK DETECTOR	5.	14803.96	27460.46	56442.84	30056.00	472.30	1906,20	NO
1	22	A1A3	PSK RECEIVE LOGIC	3.	20551.78	45767.43	124586.39	96614.00	1099.90	1891,40	NO
1	23	A1A5	PSK TRANSMIT LOGIC	4.	17176.64	34325.57	78693.64	72711.00	668.40	1989,90	NO
1	999			4.	17176.64	34325.57	78693.64	2000000.00	81.50	5184,80	YES

R E L I A B I L I T Y

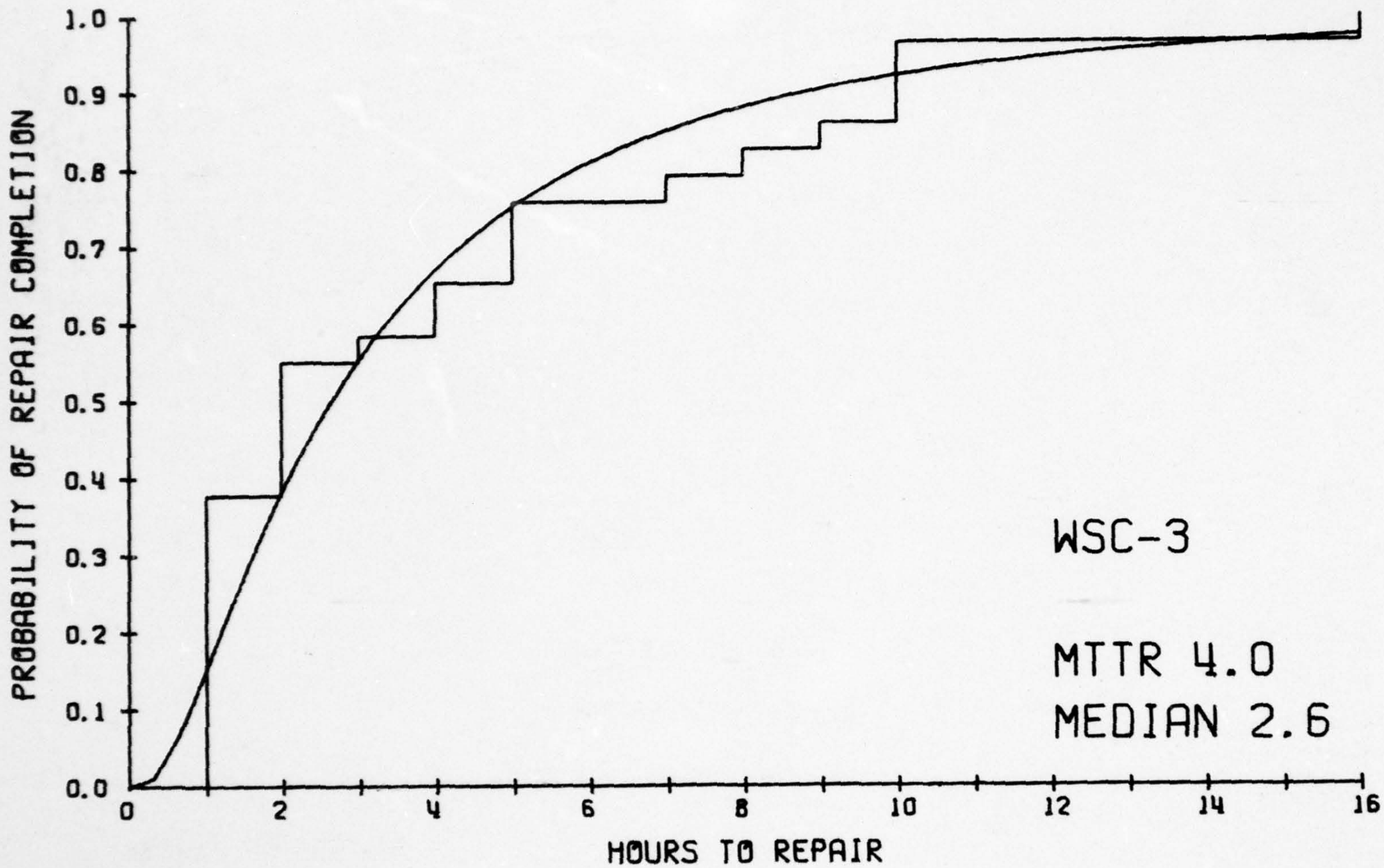
2K SUMMARY FOR WSC-3 PROBLEM AREAS

JCN	SYSTEM	WRA	D-L	C-L	J-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
04663DE020096	2	1	999	0	0	NO XMIT KEY		R R CP22 ? MODULE
04679DE02M061	2	1	4	0	0	NO T/R	ALL BIT	ESHORTED CAP IC A23
05148DC010287	2	1	999	0	0	NO RCV AM	NONE	REP BROKEN WIRE
05849	2	1	4	0	0			RPL WSC-3"REP 5MHZ
05850DE01M132	2	1	999	0	0	NO CPY FSK	BITE 22	
20122	2	1	5	4	0	DOWN REPLAC	D	RPL SYNTH /FREQ ST
52197DE01M164	2	1	999	0	0	NO RCV	SW 16	CHG CABLE STRAP

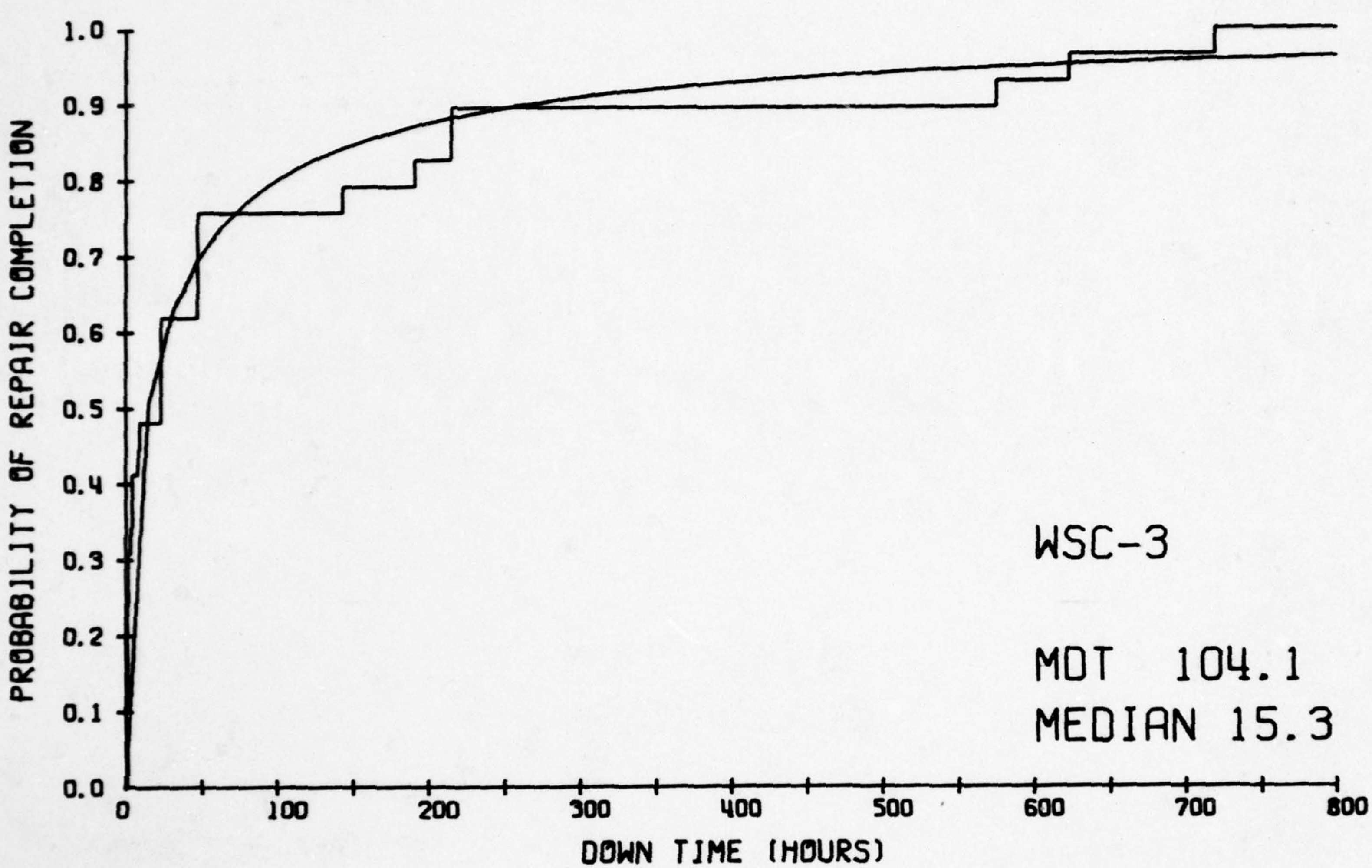
CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
EXPONENTIAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL LOGNORMAL PROBABILITY DISTRIBUTION FOR TIME TO REPAIR



CUMULATIVE OBSERVED DISTRIBUTION VERSUS THEORETICAL
LOGNORMAL PROBABILITY DISTRIBUTION FOR DOWN TIME



FLEET MAINTAINABILITY ASSESSMENT DATA

WRA	OL1	OL2	OL3	DISCOVERY DATE	COMPLETION DATE	DOWN TIME (HRS)	REPAIR TIME (HRS)	SYS	UIC
1	23	0	0	6198	6198	0.0	0.0	2	03135
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	22	0	0	6252	6252	2.0	2.0	2	03368
1	12	0	0	6354	6354	1.0	1.0	2	03368
1	1	0	0	6258	6258	5.0	5.0	2	04663
1	9	0	0	6268	6268	1.0	1.0	2	04663
1	999	0	0	7060	7061	24.0	8.0	2	04663
1	6	0	0	6194	6195	24.0	10.0	2	04664
1	5	0	0	6209	6211	48.0	2.0	2	04668
1	4	0	0	6169	6169	5.0	5.0	2	04679
1	5	0	0	6177	6183	144.0	1.0	2	04679
1	22	1	0	6205	6229	576.0	5.0	2	04679
1	23	0	0	6256	6264	192.0	2.0	2	04679
1	18	0	0	6246	6246	0.0	0.0	2	04691
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	9	0	0	6322	6322	0.0	0.0	2	04691
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	9	0	0	6194	6196	48.0	1.0	2	04698
1	18	0	0	6162	6188	624.0	7.0	2	04699
1	9	0	0	6241	6241	0.0	0.0	2	05058
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	14	0	0	6349	6349	1.0	1.0	2	05117
1	14	0	0	6171	6173	48.0	2.0	2	05148
1	999	0	0	6181	6181	10.0	10.0	2	05148
1	1	0	0	6181	6181	9.0	9.0	2	05148
1	14	0	0	6286	6286	1.0	1.0	2	05148
1	5	0	0	6322	6322	1.0	1.0	2	05148
1	23	0	0	6236	6245	216.0	4.0	2	05849
1	4	0	0	6256	6256	0.0	0.0	2	05849
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	999	0	0	6196	6226	720.0	1.0	2	05850
1	5	0	0	6229	6231	48.0	1.0	2	20019
1	9	18	0	6202	6211	216.0	16.0	2	20028
1	5	0	0	6365	6365	0.0	0.0	2	20028
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	18	0	0	6253	6253	2.0	2.0	2	20044
1	5	4	0	6195	6195	0.0	0.0	2	20122
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	18	0	0	6269	6269	4.0	4.0	2	20122
1	999	0	0	6209	6210	24.0	3.0	2	58197
1	9	0	0	6223	6223	1.0	1.0	2	52704
1	9	0	0	6245	6245	0.0	0.0	2	52704
			NO REPAIR TIME FOR THE ABOVE RECORD						
1	23	15	0	6260	6261	24.0	10.0	2	54057
1	22	0	0	6345	6345	1.0	1.0	2	54057

MAINTAINABILITY (REPAIR TIME)

WSC-3 SYSTEM LEVEL

REPAIR TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	11.	11.0	.367	.151	.216
2.0	5.	16.0	.533	.385	.149
3.0	1.	17.0	.567	.556	.022
4.0	2.	19.0	.633	.672	.106
5.0	3.	22.0	.733	.753	.120
7.0	1.	23.0	.767	.852	.118
8.0	1.	24.0	.800	.882	.116
9.0	1.	25.0	.833	.905	.105
10.0	3.	28.0	.933	.923	.089
16.0	1.	29.0	.967	.973	.040

TOTAL REPAIR HOURS = 117.0 NUMBER OF REPAIRS = 29. OBSERVED REPAIR RATE/HR = .2479E+00

DISTRIBUTION DETERMINATION

MEAN OF LN'S = .97 STD DEV OF LN'S = .94

K-S CRITICAL VALUE (.10, 29.) = .148 MAX DIFF CALC = .216 IS GREATER THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION CANNOT BE ASSUMED

REPAIR TIME	FREQUENCY	CUM FREQUENCY	NPF	EXPONENTIAL	MAX DIFFERENCE
1.0	11.	11.	.367	.220	.147
2.0	5.	16.	.533	.391	.142
3.0	1.	17.	.567	.525	.042
4.0	2.	19.	.633	.629	.062
5.0	3.	22.	.733	.710	.077
7.0	1.	23.	.767	.824	.090
8.0	1.	24.	.800	.862	.096
9.0	1.	25.	.833	.893	.093
10.0	3.	28.	.933	.916	.083
16.0	1.	29.	.967	.981	.068

TOTAL REPAIR HOURS = 117.0 NUMBER OF REPAIRS = 29. OBSERVED REPAIR RATE/HR = .2479E+00

DISTRIBUTION DETERMINATION

K-S CRITICAL VALUE (.10, 29.) = .177 MAX DIFF CALC = .147 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE EXPONENTIAL DISTRIBUTION IS ASSUMED

EST MEAN = 4.03 EST MEDIAN = 2.80 90 PER CENT LCL ON MEAN = 3.24 90 PER CENT UCL ON MEAN = 5.23

SPECIFIED MTTR = .17 HOURS LOWER CONF LIM 3.24 IS GREATER THAN MTTR, THUS A MAINTAINABILITY PROBLEM EXISTS

MAINTAINABILITY (DOWN TIME)

WSC-3 SYSTEM LEVEL

DOWN TIME	FREQUENCY	CUM FREQUENCY	NPF	LOGNORMAL	MAX DIFFERENCE
1.0	7.	7.0	.233	.110	.123
2.0	2.	9.0	.300	.180	.120
4.0	1.	10.0	.333	.273	.060
5.0	2.	12.0	.400	.308	.092
9.0	1.	13.0	.433	.406	.027
10.0	1.	14.0	.467	.425	.042
24.0	4.	18.0	.600	.581	.114
48.0	4.	22.0	.733	.697	.097
144.0	1.	23.0	.767	.844	.110
192.0	1.	24.0	.800	.873	.106
216.0	2.	26.0	.867	.883	.083
576.0	1.	27.0	.900	.949	.082
624.0	1.	28.0	.933	.952	.052
720.0	1.	29.0	.967	.959	.025

TOTAL DOWN TIME (TDT) = 3020.0 NUMBER OF REPAIRS (NR) = 29. OBSERVED DOWN TIME/REPAIR (TDT/NR) = 104.14

DISTRIBUTION DETERMINATION

MEAN OF LN'S = 2.73 STD DEV OF LN'S = 2.22

K-S CRITICAL VALUE (.10, 29.) = .148 MAX DIFF CALC = .123 IS LESS THAN THE CRITICAL VALUE

THEREFORE THE LOGNORMAL DISTRIBUTION IS ASSUMED

EST MEAN = 104.14 EST MEDIAN = 15.26 90 PER CENT LCL ON MEDIAN = 8.88 90 PER CENT UCL ON MEDIAN = 26.24

MAINTAINABILITY (REPAIR TIME)

WSC-3 O-LEVEL SUMMARY

WRA	O-LEVEL BLOCK NO.		O-LEVEL NOMENCLATURE	NUMBER REPAIRS	LOWER 90 CONF LIM	UPPER 90 CONF LIM	SPEC MTTR	OBSERVED REPAIR TIMES LOW	MEAN	HIGH	MAINT PROBLEM
1	1	A1A2	POWER SUPPLY VOLTAG REGULATOR	3.	4.20	8.80	.2	5.0	6.33	9.0	YES
1	4	A1A23	FREQUENCY STANDARD	1.	NO CONF LIMITS		.2	5.0	5.00	5.0	
1	5	A1A8	SYNTHESIZER	4.	.90	1.58	.2	1.0	1.25	2.0	YES
1	6	A1A9	CONTROL CONVERTER	1.	NO CONF LIMITS		.2	10.0	10.00	10.0	
1	9	A1A1	EXCITER / PA	4.	.64	6.22	.2	1.0	4.75	16.0	YES
1	12	A1A22	VOLTAGE CONTROLLED OSCILLATOR	1.	NO CONF LIMITS		.2	1.0	1.00	1.0	
1	14	A1A15	A M DETECTOR	3.	.81	1.95	.2	1.0	1.33	2.0	YES
1	15	A1A10	FM/PSK/FSK MODULATOR	1.	NO CONF LIMITS		.2	10.0	10.00	10.0	
1	18	A1A7	PSK DETECTOR	4.	2.66	11.25	.2	2.0	7.25	16.0	YES
1	22	A1A3	PSK RECEIVE LOGIC	3.	.89	5.19	.2	1.0	2.67	5.0	YES
1	23	A1A5	PSK TRANSMIT LOGIC	3.	1.79	10.38	.2	2.0	5.33	10.0	YES
1	999			4.	1.66	9.32	.2	1.0	5.80	10.0	YES

MAINTAINABILITY (REPAIR TIME)

2K SUMMARY FOR WSC-3 PROBLEM AREAS

JCN	SYSTEM	WRA	O-L	O-L	O-L	SYSTEM SYMPTON	DIAGNOSTIC	RESULTS
031350E01	2	1	23	0	0	PSK INOP	VISUAL	RPL LOGIC MOD A5
033680E021386	2	1	22	0	0	FAULT LITE	BITE	REPL LOGIC MODULE
033680E021552	2	1	12	0	0	NO XMT/RCV	BITE 5	REPLACED VCO
046630E02M114	2	1	1	0	0	NO OUTPUT	VISUAL	RPL V.REG DIODES
046630E02M114	2	1	9	0	0	NO AUDIO	NONE	REPLACED XMTR
046630E020096	2	1	999	0	0	NO XMIT KEY		R R CR22 ? MODULE
046640E020449	2	1	6	0	0	NOT KEY	VISUAL	RPL CONT CONVERTER
046680E01C081	2	1	5	0	0	DATA BK UP	NONE	REPLACED SYNTH
046790E02M061	2	1	4	0	0	NO T/R	ALL BIT	ESHORTED CAP IN A23
046790E02M067	2	1	5	0	0	NO RCV AM	BITE	RPL SYNTHESIZER
046790E02M070	2	1	22	1	0	NO RCV PSK	BITE	RPL VR,PS LOG MOD
046790E02M085	2	1	23	0	0	NO XMT PSK	NONE	RPL XMT LOGIC MOD
046910E020500	2	1	18	0	0	NOT RCV PSK	BITE	RPL PSK DETECTOR
046910E020516	2	1	9	0	0	NO TRANSMIT	BITE 10	REPLACED XMTR
046980E01A782	2	1	9	0	0	NO XMT	NONE	RPL XMTR MOD
046990E21A321	2	1	18	0	0	NO DET PSK	NONE	RPL PSK DET
050580C010388	2	1	9	0	0	NO PWROUT		REPLACED XMTR
051170C010477	2	1	14	0	0	NO RCV AM		RPL AM DETECTOR
051480E01	2	1	14	0	0	NO SQUELCH	BITE	RPL RF-AM DET
051480C010287	2	1	999	0	0	NO RCV AM	NONE	REP BROKEN WIRE
051480C010286	2	1	1	0	0	NO 28 V	NONE	RPL V. REG
051480E010836	2	1	14	0	0	NO SQUELCH	BITE	RPL RF-AM DETT
051480E010857	2	1	5	0	0	NO FUNCT	BITE LI	TREPLACED SYNT
058490E01	2	1	23	0	0	BAD STRAP	NONE	CHANGED STRAPPING
05849	2	1	4	0	0			RPL WSC-3"REP 5MHZ
058500E01M132	2	1	999	0	0	NO CPY FSK	BITE 22	
200190E011232	2	1	5	0	0	XMT FREQ BA	D NONE	RPL SYNTHESIZER
200280E010872	2	1	9	18	0	NO RCV SAT	BITE	RPL XTROO + PSK DT
20028	2	1	5	0	0			RPL SYNTHESIZER
200440C010170	2	1	18	0	0	NO RCV PSK	NONE	RPL PSK DET
20122	2	1	5	4	0	DOWN REPLAC	D	RPL SYNTH /FREQ ST
201220E01	2	1	18	0	0	NO RCV PSK	NONE	RPL PSK DET
521970E01M164	2	1	999	0	0	NO RCV	SW 16	CHG CABLE STRAP
52704WP010800	2	1	9	0	0	NO PWR		BUSTED A1A1A10R2
52704WP01	2	1	9	0	0	XMTR BROKE	IVISUAL	RPL XMTR
540570E011546	2	1	23	15	0	NO PSK	CV PSK	RPL LOGIC, DATA MD
540570E011560	2	1	22	0	0	NONE	BITE 21	RPL PHASE SHFTLOG

RMA SUMMARY WSC-3 SYSTEM LEVEL

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TTF DISTRIBUTION IS WEIBULL WITH ALPHA =    .00450 AND BETA =    .65380   MEAN =   5221.06
DT  DISTRIBUTION IS LOGNORMAL WITH MEAN OF LNS  =   2.73000 AND STANDARD DEVIATION OF LNS  =   2.22000
RT  DISTRIBUTION IS EXPONENTIAL WITH MEAN =      4.03
            INHERENT AVAILABILITY = MTBF/(MTBF+MTTR)
MEAN TIME TO FAILURE   =  5221.06
MEAN REPAIR TIME       =      4.03
INHERENT AVAILABILITY =     .9992
            OBSERVED AVAILABILITY (SIMULATION OF RATIOS  TTF/(TTF+DT))
90 PERCENT LCL ON INDIVIDUALS =      .6733
90 PERCENT UCL ON INDIVIDUALS =      .9968
MEAN                          =      .9052
MEDIAN                        =      .9839
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